Declaration for the Record of Decision (ROD)
Sheboygan River and Harbor

A. SITE NAME AND LOCATION

Sheboygan River and Harbor
Sheboygan, Wisconsin

B. STATEMENT OF BASIS AND PURPOSE

This decision document presents the remedial action selected by U.S. EPA for the Sheboygan River and Harbor site in Sheboygan, Wisconsin. U.S. EPA selects this remedial action in accordance with the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and, to the extent practicable with the National Contingency Plan (NCP). The decisions here are based on information in the administrative record for this site. However, occasionally references are made to specific documents, in the administrative record, where the information is too voluminous to provide here.

The State of Wisconsin is not expected to concur with the selected remedy.

C. ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from the site, if not addressed by implementing the response actions selected by U.S. EPA in this ROD, may present an imminent and substantial endangerment to human health, welfare, or the environment.

D. DESCRIPTION OF THE SELECTED REMEDY

The objectives of the response actions approved for this Site are to protect public health, welfare and the environment and to comply with applicable federal and state laws. The remedy outlines specific actions to address polychlorinated biphenyl (PCB) contaminated sediment, PCB-contaminated floodplain soil, and ground-water contamination.

The major components of the selected remedy include:

- Upper River sediment characterization, removal of approximately 20,774 cubic yards of PCB-contaminated sediment to achieve a soft sediment surface weighted average concentration (SWAC) of 0.5 parts per million (ppm) in the Upper River, and fish and sediment sampling to document natural processes and ensure that over time the entire river will reach an average PCB sediment concentration of 0.5 ppm or less.

- Middle River sediment characterization, removal of sediment if necessary to achieve a soft sediment SWAC of 0.5 ppm in the Middle River, and fish and sediment sampling to document natural processes and ensure that over time the entire river will reach an average PCB sediment concentration of 0.5 ppm or less.
- Lower River sediment characterization, removal of sediment if necessary to achieve a soft sediment SWAC of 0.5 ppm in the Lower River, annual bathymetry surveys to identify areas susceptible to scour, and fish and sediment sampling to document natural processes and ensure that over time the entire river will reach an average PCB sediment concentration of 0.5 ppm or less.
- Inner Harbor sediment characterization, removal of approximately 53,000 cubic yards of PCB-contaminated sediment to achieve a SWAC of 0.5 ppm in the Inner Harbor, annual bathymetry surveys to identify areas susceptible to scour, fish and sediment sampling to document natural processes and ensure that over time the entire river will reach an average PCB sediment concentration of 0.5 ppm or less, and maintenance of the outer harbor breakwalls.
- Removal of floodplain soils containing PCB concentrations above 10 ppm.
- Investigation and mitigation of potential groundwater contamination and possible continuing sources at the Tecumseh Products Company plant in Sheboygan Falls ("Tecumseh's Sheboygan Falls plant").

E. STATUTORY DETERMINATIONS

The selected remedy is protective of human health and the environment, complies with federal and state applicable or relevant and appropriate requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost effective. This remedy utilizes permanent solutions and alternative treatment technologies, to the maximum extent practicable. It does not satisfy the statutory preference for treatment that reduces toxicity, mobility, or volume through treatment as a principal element because the PCB-contaminated sediment that will be removed from the river is not anticipated to be treated prior to disposal.

Because this remedy will result in hazardous substances remaining on site at levels preventing unlimited exposure and unrestricted use after the remedial action has taken place, the five-year review requirement applies to this action.

F. DATA CERTIFICATION CHECKLIST

The following information is in the *Decision Summary* section of this ROD. Additional information is in the administrative record file for this site.

✓ Chemicals of concern (COCs) and their respective concentrations
✓ Baseline risk represented by the COCs
✓ Cleanup levels established for COCs and the basis for the levels

- ✓ Current and future land and ground-water use assumptions used in the baseline risk assessment and ROD
- ✓ Land and ground-water use that will be available at the site as a result of the selected remedy
- ✓ Estimated capital, operation and maintenance (O&M), and total present worth costs; discount rate; and the number of years over which the remedy cost estimates are projected
- ✓ Decisive factor(s) that led to selecting the remedy (*i.e.*, describe how the selected remedy provides the best balance of tradeoffs with respect to the balancing and modifying criteria)

________________ ________________________________

Date

William E. Muno
Superfund Division Director

U.S. EPA SUPERFUND
RECORD OF DECISION

SHEBOYGAN RIVER AND HARBOR

SHEBOYGAN, WISCONSIN
MAY 2000

TABLE OF CONTENTS

EXHIBITS

COST TABLES

Upper River Alternative 2, Natural Recovery and Disposal of CTF & SMF Sediments (detailed estimate and present worth analysis)
Upper River Alternative 3-I, Sediment Removal (detailed estimate and present worth analysis)
Upper River Alternative 3-II, Sediment Removal (detailed estimate and present worth analysis)
Upper River Alternative 3-III, Sediment Removal (detailed estimate and present worth analysis)
Upper River Alternative 3-IV, Sediment Removal (detailed estimate and present worth analysis)
Upper River Alternative 3-IV-A, Sediment Removal (detailed estimate and present worth analysis)
Upper River Alternative 3-V, Sediment Removal (detailed estimate and present worth analysis)

Middle River Alternative 2, Characterization and Monitored Natural Processes (detailed estimate and present worth analysis)
Middle River Alternative 3, Characterization, Sediment Removal and Monitored Natural Processes (detailed estimate and present worth analysis)

Lower River and Inner Harbor Alternative 2, Monitored Natural Processes (detailed estimate and present worth analysis)
Lower River and Inner Harbor Alternative 3, Sediment Trap (detailed estimate and present worth analysis)
Lower River and Inner Harbor Alternative 4, Sediment Removal Due to Natural and Recreational Impacts (detailed estimate and present worth analysis)
Lower River and Inner Harbor Alternative 5, Sediment Cap (detailed estimate and present worth analysis)
Lower River and Inner Harbor Alternative 6, Surface Sediment Removal (detailed estimate and present worth analysis)
Lower River and Inner Harbor Alternative 7, Complete Excavation (detailed estimate and present worth analysis)

Floodplain Soil Alternative 2, Bank Soil Stabilization (detailed estimate and present worth analysis
Floodplain Soil Alternative 3, Soil Removal with PCBs> 50 ppm (detailed estimate and present worth analysis
Floodplain Soil Alternative 4, Soil Removal with PCBs> 10 ppm (detailed estimate and present worth analysis

APPENDICES

RECORD OF DECISION SUMMARY
SHEBOYGAN RIVER AND HARBOR
CERCLIS ID: WID 980 996 367

A. SITE NAME, LOCATION, AND BRIEF DESCRIPTION

The Sheboygan River and Harbor Site is located on the western shore of Lake Michigan approximately 55 miles north of Milwaukee, Wisconsin, in Sheboygan County. See Figure 1 - Location Map

The Sheboygan River and Harbor site includes the lower 14 miles of the river from the Sheboygan Falls Dam downstream to, and including, the Inner Harbor. See Figure 2, Site Map. This segment of the river flows through Sheboygan Falls, Kohler, and Sheboygan before entering Lake Michigan. The Sheboygan River runs from west to east through east central Wisconsin, emptying into Lake Michigan.

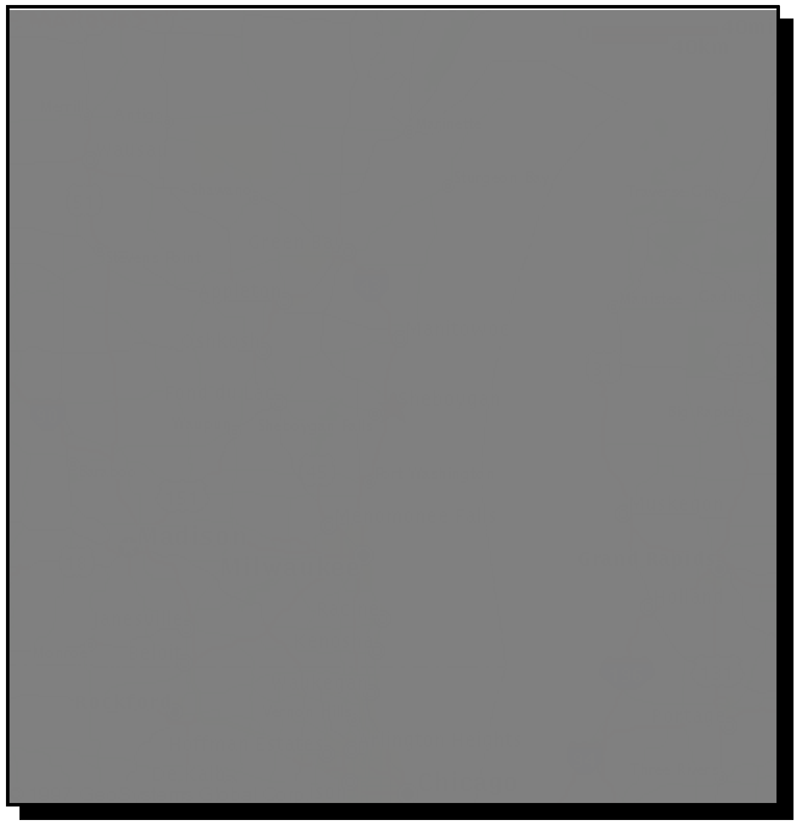


Figure 1 - Location Map

U.S. EPA divided the river into three sections, during the remedial investigations (RI), based on physical characteristics such as average depth, width, and level of polychlorinated biphenyl (PCB) sediment contamination. The Upper River extends from the Sheboygan Falls Dam downstream 4 miles to the Waelderhaus Dam in Kohler. The Middle River extends 7 miles from the Waelderhaus Dam to the former Chicago & Northwestern (C&NW) railroad bridge. The Lower River extends 3 miles from the C&NW railroad bridge to the Pennsylvania Avenue bridge in downtown Sheboygan. The Inner Harbor includes the Sheboygan River from the Pennsylvania Avenue Bridge to the river's outlet to the Outer Harbor. The Outer Harbor is defined as the area formed by the two breakwalls.

In addition to PCB-contaminated sediment in the river and harbor, some floodplain soils are contaminated with PCBs, as seen in Figure 2. Lastly, there remain questions concerning possible ground-water contamination and additional PCB sources associated with the Tecumseh Products Company (Tecumseh) Plant, one of the three identified potentially responsible parties (PRPs) for this site. Kohler Company and Thomas Industries are the other two PRPs for the site.

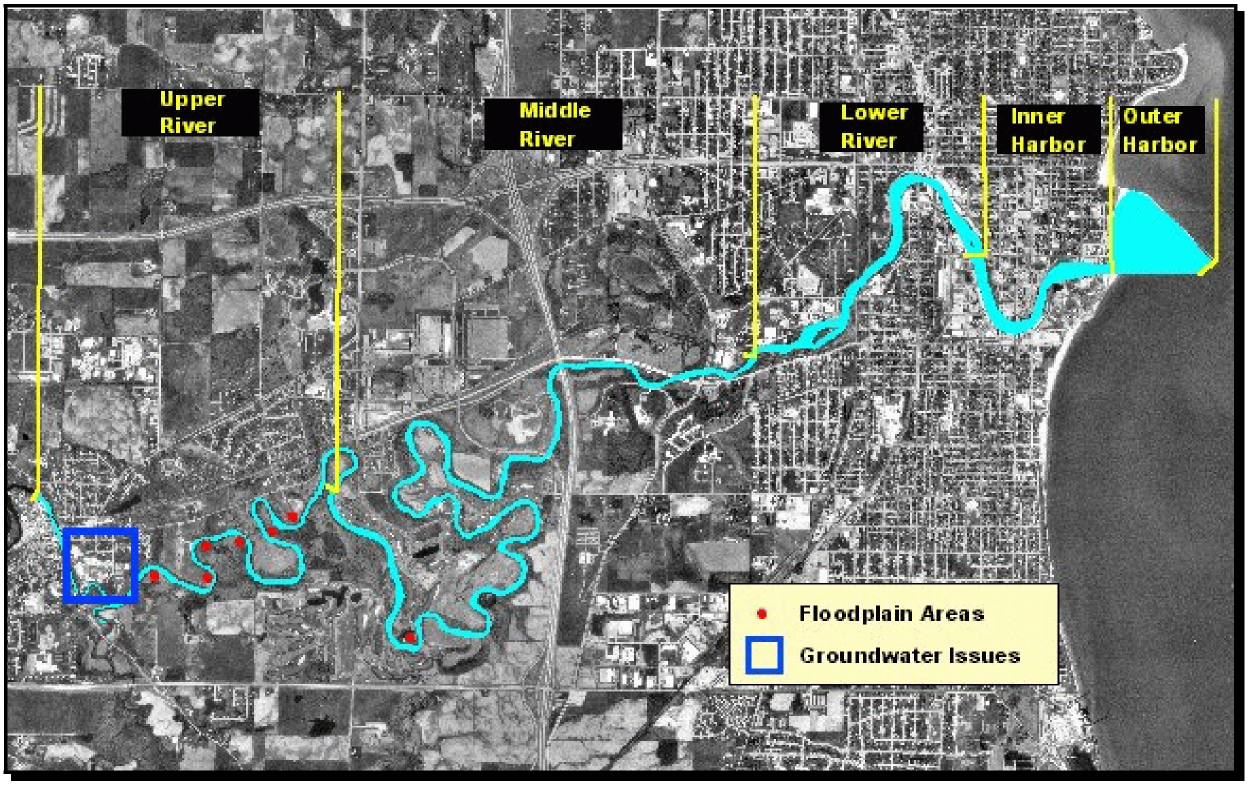


Figure 2 - Site Map

Tecumseh Products Company performed the early removal actions and the remedial investigation / feasibility study (RI/FS). U.S. EPA anticipates that one or more of the PRPs will implement the remedy.

B. SITE HISTORY AND ENFORCEMENT ACTIVITIES

The Sheboygan Harbor was constructed at the mouth of the Sheboygan River in the early 1920's. In 1954, the lower Sheboygan River, namely the channel upstream of the Eighth Street Bridge, was added as a portion of the Sheboygan Harbor for United States Army Corps of Engineers (USACE) maintenance dredging. Between 1956 and 1969, a total of 404,000 cubic yards of sediment were dredged downstream of the Eighth Street Bridge. The channel above Eighth Street has not been dredged since it was first dredged in 1956.

Prior to 1969, the USACE disposed of the dredged material from the Harbor in an authorized deep water disposal area in Lake Michigan. However, there has been no dredging within the Sheboygan Harbor since the U.S. EPA and WDNR determined that the sediment was unsuitable for open-water disposal. Sediment sampling done by the USACE in 1979, indicated moderate-to-high levels of lead, zinc, PCBs and chromium

and moderate levels of arsenic present in sediment at all locations sampled. The USACE routinely removed lake sand from a sandbar that forms at the outer entrance of the Harbor. The USACE last dredged the Harbor mouth in the Fall of 1991.
In June 1979, the USACE collected 11 sediment cores from the Harbor area ranging in depth from 1.5 to 9 feet. The USACE analyzed samples for lead, zinc, copper, chromium, and PCBs. The study revealed greater PCB and metal levels in the sediment of the Inner Harbor than in sediment from the Outer Harbor. In October 1979, the USACE collected a second round of samples consisting of 21 sediment cores. The USACE's analysis of these cores generally indicated an increase in PCB concentrations with the distance upstream from the Harbor and with the depth of the sediment. The Sheboygan River and Harbor are designated an Area of Concern by the International Joint Commission on the Great Lakes due to impairment of the beneficial uses of the waterway.

Examination of 98 sediment profile samples collected by the USACE from the Sheboygan Harbor from December 2 to 6, 1982, indicated the presence of PCBs in the surface sediment of the Harbor. The possibility that this sediment may be classified as regulated material (for PCBs and metals) has contributed to the impasse of implementing an acceptable maintenance dredging effort.

Tecumseh, a manufacturer of refrigeration and air conditioning compressors and gasoline engines, is located adjacent to the Sheboygan River in Sheboygan Falls. Tecumseh is considered a PRP because PCBs were found in sewer lines that lead to the River from Tecumseh and in hydraulic fluids used in Tecumseh Products Company's Diecast Division manufacturing processes. The contamination level is high in the sediments immediately surrounding the Tecumseh Plant, but decreases in concentration downstream. Tecumseh, prior to the issuance of regulations governing PCBs, used PCB-contaminated soils to construct a dike located along the river downstream of the Sheboygan Falls Dam. Tecumseh voluntarily excavated and replaced the dike following the U.S. EPA's issuance of regulations governing PCBs in the late 1970's. Tecumseh undertook cleanup actions, but not before PCBs released into the Sheboygan River.

In 1978, the Wisconsin Department of Natural Resources (WDNR) conducted a survey that found numerous industries that discharge contaminants to the Sheboygan River. A handful had some level of PCB discharge to the river. A number of industries had heavy metals in their discharge. While heavy metals are an environmental concern, PCBs are a more significant problem and any PCB driven cleanup would address the heavy metals in the river.

In 1975 and 1976, the WDNR analyzed several industrial outfalls in the state for PCBs. From the WDNR files and the Thomas Industries response to a U.S. EPA Request for Information in 1985, two outfalls from Thomas Industries, located in the area of concern, contained PCBs when analyzed by WNDR on two different dates. The discharge to the Sheboygan Wastewater Treatment Plant contained 35.0 parts per billion (ppb) PCBs on December 3, 1975 and 1000 ppb on March 25, 1976. An outfall to the Sheboygan River via a storm sewer contained 125 ppb PCBs on June 13, 1976. Another outfall to the Sheboygan River via a storm sewer contained 125 ppb PCBs on June 13, 1975 and 88 ppb on August 19, 1975.

Thomas Industries operated an aluminum die cast shop, which has been in operation at Plant #1 since the late 1950's. The machine shop operations consisted of milling, drilling, boring and tapping of aluminum, steel, powder metal, cast iron, zinc and brass materials, and finishing and cleaning aluminum parts by acid wash, degreasing, vibratory and spindle finishing.

Kohler Company, located in Kohler, Wisconsin downstream of Sheboygan Falls, was found to have heavy metal discharges to the river above its permit limits in the 1970's. In addition, the Kohler Landfill Superfund site is located on the banks of the river adjacent to Kohler property. The State of Wisconsin is currently overseeing the closure of that facility. There were historic releases of heavy metals and PCBs from the landfill that are currently being addressed through the facility closure plan.

U.S. EPA placed the Sheboygan River and Harbor site on the National Priorities List (NPL) in 1986.

In 1989 and 1990, U.S. EPA requested Tecumseh to conduct actions to remove about 5,000 cubic yards of contaminated sediment. This sediment was stored in two containment facilities at Tecumseh's Sheboygan Falls plant. In addition, approximately 1,200 square yards of highly contaminated sediment were capped or "armored" in place to prevent contaminants in the sediment from entering the river. Information developed during these activities is described in a document called an Alternative Specific Remedial Investigation (ASRI) report.

C. COMMUNITY PARTICIPATION

U. S. EPA places all pertinent documents related to the site in information repositories established at the Mead Public Library, 710 N. 8th St., Sheboygan and the Sheboygan City Hall, 828 Center Ave., Sheboygan. Administrative records have also been established at the Mead Public Library and the U.S. EPA Records Center, 77 W. Jackson Blvd., Chicago, Illinois.

The Region sent several fact sheets to entities on the mailing list including fact sheets dated April 1986, August 1987, Spring 1988, June 1988, June 1989, September 1989, September 1990, June 1991, February 1992, August 1992, February 1993, May 1994, December 1995, November 1998, January 1999 and July 1999.

U.S. EPA issued a Proposed Plan in May 1999, to inform the community of the proposed remedy for the site. The community was informed of a public comment period and a public meeting via the Proposed Plan and advertisements in the Sheboygan Press on May 27, and June 24, 1999. Another advertisement announcing the extension of the public comment period through August 13 appeared on June 28, 1999. The public comment period was started on June 1, 1999. On June 30, 1999, U.S. EPA sponsored a public meeting at the Mead Public Library to explain the proposed remedy, answer questions and receive public comments. A commentor requested an extension to the comment period which was granted. The entire pubic comment period lasted 75 days.

The Region held other public meetings during the RI/FS process including those on April 24, 1986, June 27, 1988, Sept. 7, 1989, and September 20, 1990. The Region sent letters to the mailing list to invite local citizens and officials to a Dec. 9, 1989 tour of the dredging operation and Confined Treatment Facility. More than 60 people attended this event.

The Lake Michigan Federation received a Technical Assistance Grant in February 1994. The group used its grant to hire two advisors to assist with interpreting technical information and disseminating it to the community. A couple of newsletter articles, a fact sheet, two June 24, 1999 availability sessions and formal public comments were provided by the Lake Michigan Federation.

The public submitted approximately 200 verbal and written comments during the public comment period. The verbal comments were recorded by a court recorder at the June 30, 1999 public meeting and written comments were sent to U.S. EPA via postal mail and e-mail. A summary of public comments and U.S. EPA's responses are in Appendix A.

D. SCOPE AND ROLE OF RESPONSE ACTION

As with many Superfund sites, the problems at the Sheboygan River and Harbor site are complex. As a result, U.S. EPA has organized the site into five components.

- Upper River: Contamination of River Sediments
- Middle River: Contamination of River Sediments
- Lower River and Inner Harbor: Contamination of River Sediments
- Floodplain Soil: Contamination of River Floodplain Soil
- Tecumseh’s Sheboygan Falls Plant Ground-water: Contamination of Ground-water and Additional Source Identification

Upper River

The Upper River is made up of discrete soft sediment deposits and non-soft sediment areas which include a mix of soft sediment, rocks, cobbles and bare river bottom. The sediment contamination in the Upper River acts as a source of PCB-contaminated sediment for the rest of the river system and Lake Michigan.

Middle River

The Middle River is also made up of soft and non-soft sediment areas, but due to the hydrodynamics of this stretch of the river, the areas of soft sediment are shallower and more widely scattered. Similar to the Upper River, the Middle River also acts as a source of PCB-contaminated sediment for the rest of the river system and Lake Michigan.

Lower River and Inner Harbor

Flow in the Lower River slows and a more continuous layer of soft sediment exists. The Lower River and Inner Harbor are generally where upstream soft sediment is deposited. However, while the Inner Harbor appears to be generally depositional, net deposition occurs primarily between the 8th Street Bridge and the harbor mouth. The area between the Pennsylvania Avenue and 8th Street Bridges has undergone relatively little deposition in recent years and shows evidence of scour.

Floodplain Soil

Contaminated floodplain soil is primarily located in the Upper River segment of the river. Flood events make these PCB-contaminated soils sources for the river and the animals coming in contact with contaminated surface soil. Removal of these areas will remove these current and future potential sources to the River.

Tecumseh’s Sheboygan Falls plant Ground-water

Contaminated ground-water and Tecumseh’s discontinued discharge sewer lines underneath the Tecumseh’s Sheboygan Falls plant may pose a threat of PCB release to the River. In addition, soft sediment and river bank samples taken near the Tecumseh plant in 1999 indicated that additional PCB sources on or near the Tecumseh Products Company property likely exist.

E. SITE CHARACTERISTICS

The river is generally characterized by fast, rocky stretches in the upper reaches and slower, more sediment-laden stretches in the lower reaches. The width of the Upper River averages 120 feet and the depth ranges from 1 to 4 feet. The river widens as it approaches the harbor. Harbor water quality is a combination of near-shore lake water and water from the Sheboygan River. There is an influx of sand from the lake into the Outer Harbor caused by currents and wind-driven wave action. The extent to which this sand has deposited into the harbor has not been well established; however, it is presumably minimal due to the limited frequency of maintenance dredging by the

USACE. The depth of light penetration is lowest in the river, increasing to a maximum outside the harbor. Water temperature decreases markedly from the river to the lake. Moderate levels of major nutrients (e.g., nitrate, soluble reactive phosphate, total phosphorus) are in the river and are diluted by the nutrient-poor lake water in the harbor.

Geologically, the site lies on the Lake Michigan basin and is generally underlain by glacial drift. The drift is in turn underlain by Niagaran limestone and/or dolomite. The deeper formations are the Maquoketa Shale, the Sinnipee Group, and St. Peter Sandstone. Harbor sediment consists of clay, silt, sand, and organic material underlain by dense glacial till. In many locations, the Sheboygan River has incised itself into the underlying Niagaran limestone.

Nature and Extent of Contamination

Tecumseh investigations, between 1987 and 1990, defined the nature and extent of contamination at the site and describe the extent of the threat that contaminants pose to human health and the environment. Tecumseh obtained additional data as recently as June 1999. The primary compounds of concern were determined to be PCBs, and several heavy metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc). PCBs drive risk and, therefore, the cleanup alternatives described are primarily focused on removing PCB-contaminated sediments and soils. However, metals, volatile organic compounds (VOCs) and polynuclear aromatic hydrocarbons (PAHs) were also detected at varying concentrations.

Over the course of the investigation, Tecumseh, the Wisconsin Department of Natural Resources and the National Oceanic and Atmospheric Agency have all collected samples from the Sheboygan River.

Eight metals including cadmium, chromium, copper, lead, mercury, nickel and zinc were targeted as part of the RI. Generally, the metals occurred at relatively low concentrations in the upstream sediments and increase in the downstream sediments. Common natural elements such as aluminum, calcium, iron, magnesium, potassium, and sodium are also present.

Sampling detected five VOCs, including methylene chloride, acetone, chloroform, methyl ethyl ketone, and toluene in the river sediments. VOCs were generally found in low concentrations in the river sediment. However, acetone was detected at levels up to 270 ppb, while toluene was detected at levels up to 740 ppb.

PAHs are commonly associated with petroleum products, waste oil, and coal tars. During the RI the total estimated PAH concentrations were at, or below, 2.0 ppm for nine of the ten river samples obtained. The tenth sample had a PAH concentration of 4 ppm. In 1998, PAH sampling conducted by the Wisconsin Public Service Corporation for a project managed by the Wisconsin Department of Natural Resources showed total PAH concentrations from non-detect to 9,294 ppm near the former Manufacturing Gas Plant site in the Lower River, just upstream of the Pennsylvania Avenue Bridge. Additional investigations and future potential remediation of PAH contaminated sediments related to this effort is being managed separately by the Wisconsin Department of Natural Resources and will not be a part of this Record of Decision.

No pesticides or dioxin/dibenzofurans were detected in the river sediments.

Table 1 - Metals Contamination (ppm)

	Upper, Middle & Lower River		Inner Harbor	
	Minimum	Maximum	Minimum	Maximum
Arsenic	1.2	16	0.7	20.4
Cadmium	ND	3.1	ND	3.7
Chromium	ND	143	2.2	414
Copper	ND	102	ND	140
Lead	3.6	293	1.1	783
Mercury	ND	0.3	ND	0.1
Nickel	ND	90	ND	354
Zinc	ND	300	ND	369

ND - Non Detected

See the May 1990 “Remedial Investigation/Enhanced Screening Report” for more detailed information relating to metals, VOCs and PAHs in their locations in the river or harbor.

PCB-Contaminated Sediment

Upper River

PCB sampling results in 1989 and 1990 showed concentrations from 1.4 to 4,500 ppm. Tecumseh removed PCB-contaminated sediment near its facility in 1990 and 1991. PCB sampling conducted in December 1997, from the same soft sediment areas sampled in 1989 and 1990 shows concentrations ranging from non-detect to 170 ppm. Soft sediment sampling in 1999, near Tecumseh's Sheboygan Falls plant, revealed PCB concentrations as high as 840 ppm. River bank sampling in 1999, near Tecumseh's Sheboygan Falls plant, revealed PCB concentrations as high as 1,100 ppm. PCB-contaminated sediment in this segment of the river migrates downstream due to the dynamic nature of this river reach.

Middle River

Information obtained during the RI showed PCB concentrations ranging from non-detect to 8.8 ppm. WDNR sediment trap data showed PCB concentrations ranging from 1.4 to 3.0 ppm. The WDNR obtained sediment trap data between 1990 and 1996. Samples obtained in 1997 by WDNR show PCB concentrations ranging from 0.6 ppm to 37 ppm. Like the Upper River, sediment in the Middle River is likely to be disturbed due to the dynamic nature of this river reach.

Lower River

During the original site investigations, sampling shows PCB concentrations as high at 67 ppm in the Camp Marina area just a couple of feet below the sediment surface. Contaminated sediments within the top two feet may be disturbed by high flow events and/or boating. WDNR sediment trap data, from 1994 to 1996, shows PCB concentrations ranging from 1.9 to 4.2 ppm in the Lower River.

Inner Harbor

Table 2 - Inner Harbor Sediment Concentrations (ppm)

Sediment Depth	Average	Minimum	Maximum
Top 1 foot	5.6	ND	117.4
1 to 2 feet	7.9	ND	89.1
2 to 4 feet	10.7	ND	103.2
4 to 6 feet	13.6	ND	82.49

RI sampling detected PCB concentrations as high as 220 ppm in the Inner Harbor, however these levels were detected in 1979 and remain many feet below the surface. PCB surface sampling results (top 6 inches) in 1987 ranged from 0.17 to 5.8 ppm. PCB surface sampling (top 6 inches) results in 1999 range from 0.38 to 5.3 ppm. Table 2 shows the average, minimum, and maximum concentration of PCBs in the top 6 feet of sediment based on all sediment data adjusted to the 1999 bathymetry and extrapolated by Earth Vision

software.
As a general rule, PCB concentrations increase with depth between the 8th Street Bridge and the Inner Harbor mouth. This, however, is not the case for certain areas between the Pennsylvania Avenue and 8th Street Bridges.

Soil

Tecumseh collected soil samples from within the 10 year floodplain of the Sheboygan River during the investigation phase of the project. Floodplain samples collected in 1990 showed PCB concentrations ranging from non-detect to 71 ppm. Tecumseh took additional rounds of samples as part of the Alternative Specific Remedial Investigation (ASRI) in 1990 and 1992. PCB concentrations exceeded 50 ppm in two samples and 10 ppm in six samples. Sampling in floodplain area 11 shows a concentration of 220 ppm. Floodplain area 11 was resampled in 1992 and shows PCB concentrations of 330 and 320 ppm. PCB concentrations have decreased in floodplain area 11 since the ASRI sampling due to disturbances of the floodplain caused by golf course construction by the land owner.

Table 3 - Surface Water Samples

	PCB Concentration (ppb)	
Date	Minimum	Maximum
April 1989	0.044	0.127
July 1989	< 0.05	0.52
November 1990	< 0.05	0.77
April 1991	< 0.05	0.08
July 1991	< 0.05	0.32
September 1991	< 0.05	0.22
October 1991	< 0.05	< 0.05
April 1992	< 0.05	< 0.05
July 1992	< 0.05	0.36
October 1992	< 0.05	0.13

Surface Water

PCB concentrations were detected in surface water prior to, during and after implementation of the PCB removal action in 1989 and 1990. The results are shown in Table 3.

Ground-water

PCB contamination is also present in ground-water at the Tecumseh plant. Ground-water sampling conducted in September 1992 and May 1993 by Tecumseh indicated that PCBs were locally present in the Tecumseh's Sheboygan Falls plant ground-water in concentrations ranging from 0.10 ug/L to 7.4 ug/L (unfiltered) and below the detection limit [0.05 ug/L] to 0.98 ug/L (filtered). These concentrations are above the 0.05 ug/L WDNR enforcement standard for ground-water.

Tecumseh estimated that the resulting flux of PCBs to the Sheboygan River was 0.4 grams/year. In a February 1998, letter to Tecumseh, the WDNR indicated that the flux could range from 0.4 to 280 gram/year, depending on the selection of input variables. Whether 0.4 or 280 grams/year, all flux calculations are conservative in that PCB retardation was not included. Given the high adsorption of PCBs to solids, the transport velocity of PCBs in ground-water is likely to be low. However, preferential pathways for flows, such as those that have been identified since the Feasibility Study was done, can greatly reduce the amount of travel time for PCB-contaminated groundwater to travel to the river. River bank samples that Tecumseh collected in 1999, near their Sheboygan Falls plant show PCB concentrations as high as 2,700 ppm where previous removal actions should have addressed concentrations of this magnitude. This PCB concentration was near a non-contact cooling water pipe outfall. Therefore, additional investigations near Tecumseh's Sheboygan Falls plant are needed to characterize any possible continuing sources, including preferential pathways, of PCBs to the Sheboygan River.

With respect to potential exposure to PCB-contaminated ground-water at Tecumseh's Sheboygan Falls plant, there are no water supply wells at the plant. Also, an existing City of Sheboygan Falls ordinance prohibits the use of private water supply wells except by permit. To prevent potential future plant personnel from using and directly contacting the PCB-contaminated ground-water, deed restrictions must be placed on Tecumseh's Sheboygan Falls plant property to prevent the installation and development of water supply wells.

Fish and Wildlife

Tecumseh collected fish tissue samples between 1990 and 1998, that show smallmouth bass and white sucker PCB concentrations ranging from 1.3 ppm to 23.1 ppm. Carp had PCB levels ranging from 10.5 to 200 ppm. In general, the highest fish tissue PCB concentrations were found nearest the Tecumseh plant and tend to decrease downstream. Fish taken from the Sheboygan River between the Sheboygan Falls dam and the mouth of the river fall into the "do not eat" consumption advisory category, and waterfowl consumption advisories are in place for some waterfowl species from the Sheboygan River below Sheboygan Falls dam to the Sheboygan harbor.

PCB concentrations in wild birds collected between 1976 and 1980 ranged from 2 to 213 ppm. In 1985 and 1986, Tecumseh monitored wildlife again for PCBs including several species of waterfowl. These analyses resulted in consumption advisories for mallards and lesser scaup in the Sheboygan River area of concern in 1987.

Fish and waterfowl advisories are for the entire 14-mile stretch from Sheboygan Falls to Lake Michigan.

F. CURRENT AND POTENTIAL FUTURE SITE AND RESOURCE USES

Land Uses

Land use along the Upper River is industrial, residential and recreational in Sheboygan Falls. The Kohler Company owns land adjacent to the Middle River in the Village of Kohler. Land use in the Middle River consists of a horse farm, tree nursery, the company's historic River Bend property and the BlackWolf Run golf course. The 800-acre, Kohler-owned River Wildlife Area is on the south side of the river adjacent to the Upper and Middle River. The wildlife area is used as a private hunting and fishing club. Land use adjacent to the Lower River and Inner Harbor is recreational, commercial and industrial with some residential areas. The City of Sheboygan's central business district is on the north bank of the of the river in the harbor area. The City is presently revitalizing the harbor area. Offices, restaurants, marinas, parks and a boardwalk are part of this plan.

Surface Water / Ground-Water Uses

There are no public beaches along the river or harbor. The Lower River and harbor are navigable, but Upper and Middle River traffic is typically restricted to smaller craft (i.e. canoes and kayaks) which can be portaged around the dams in Kohler and Sheboygan Falls, as well as shallow areas. Public and recreational boat access is available at a number of locations within the city of Sheboygan in the Lower River and harbor. There is considerable seasonal fishing in the Middle River, Lower River and Inner Harbor. Fishing is more limited in the Upper River. According to WDNR surveys, most fishing occurs during spring and fall salmon and trout runs. A fish consumption advisory is in effect for Sheboygan River and Lake Michigan fish.

The Sheboygan River is not used as a public water supply, but it drains into Lake Michigan which is used as a drinking water source by Sheboygan, Sheboygan Falls, and Kohler. The three cities regularly test the public water and it is safe to drink. Contaminated ground-water near Tecumseh's Sheboygan Falls plant is not used as a drinking water source.

G. SUMMARY OF SITE RISKS

The risk assessment estimates what risks the site poses, if no action was taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action.

For carcinogens, risks are generally expressed as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the carcinogen.

Excess lifetime cancer risk is calculated from the following equation:

$$\text{Risk} = \text{CDI} \times \text{SF}$$

where:

risk = a unitless probability (e.g., 2×10^{-5}) of an individual developing cancer
CDI = chronic daily intake averaged over 30 years (mg/kg-day)
SF = slope factor, expressed as $(\text{mg/kg-day})^{-1}$.

These risks are probabilities that usually are expressed in scientific notation (e.g., 1×10^{-6}). An excess lifetime cancer risk of 1×10^{-6} indicates that an individual experiencing the reasonable maximum exposure estimate has a 1 in a million chance of developing cancer as a result of site-related exposure. This is referenced as an “excess lifetime cancer risk” because it would be in addition to the risks of cancer individuals face from other cancer causes such as smoking or exposure to too much sun. The chance of an individual developing cancer from all other causes has been estimated to be as high as one in three. EPA’s generally acceptable risk range for site related exposures is 10^{-4} to 10^{-6} (1 in ten thousand to 1 in a million).

The potential for non-carcinogenic effects is evaluated by comparing an exposure level over a specified time period (e.g., lifetime) with a reference dose (RfD) derived for a similar exposure period. An RfD represents a level that an individual may be exposed to that is not expected to cause any deleterious effects. The ratio of exposure to toxicity is called a hazard quotient (HQ). An HQ<1 indicates that a receptor’s dose of a single contaminant is less than the RfD, and that toxic non-carcinogenic effects from that chemical are unlikely. The Hazard Index (HI) is generated by adding the HQs for all chemicals of concern that affect the same target organ (e.g., liver) within a medium or across all media to which a given population may reasonably be exposed. An HI<1 indicates that, based on the sum of all HQs from different contaminants and exposure routes, toxic noncarcinogenic effects from all contaminants are unlikely. An HI>1 indicates that site-related exposures may present a risk to human health.

The HQ is calculated as follows:

$$\text{Non-cancer HQ} = \text{CDI} / \text{RfD}$$

where:

CDI = Chronic daily intake
RfD - reference dose

CDI and RfD are expressed in the same units and represent the same exposure period.

A site conceptual model showing the potential exposure pathways can be seen in Figure 3.

Human Health Risks

A number of human health risk analyses have been performed for the site:

- Baseline Risk Analysis 7/96
- Cleanup Goal Analyses 10/98 (revised 12/99)
- Other assessments: GLNPO-ARCS 1993, Environ 1995, Endangerment assessment by Blasland and Bouck (1990)

insert figure 3 (boxed pathway figure)

Contaminants of Concern

With regards to human health risk, the main contaminant of concern is PCBs. The other contaminants of concern at the site, such as some metals, are not at levels of concern to the degree that PCBs are. While metals do present a risk, that risk will be reduced through the removal of PCB-contaminated sediments. In addition, some metals are not as bioaccumulative and persistent as PCBs. The risk driver and most prominent contaminant of concern for this site is PCBs.

In addition, the risk analysis quantitatively considered *only* the non-dioxin-like PCBs. Although this limits the analysis, U.S. EPA decided to limit the quantitative risk analysis to PCB-like congeners because the available congener data was only available at a few locations. A more qualitative assessment revealed that the dioxin-like congeners did not represent a significant increase in risks over risks estimated using total PCBs and Aroclor data.

Exposure Assessment

The physical setting of the site provides several possible pathways of exposure to the contamination in the sediment: dermal contact, ingestion of contaminated surface water or sediment, and consumption of fish contaminated by sediment. The sediments are contaminated with PCBs, hydrophobic organic compounds that will strongly prefer to partition to organic material. It is assumed then, that the most significant exposure is from contaminated sediment, where virtually all PCBs reside, and not the surface water. In general, there is likely to be only limited direct contact with the sediment itself (i.e., dermal and/or ingestion pathway). Many studies have found that *bioaccumulation* of hydrophobic organic sediment contaminants is the critical and dominant fate of these compounds in the environment. Based upon the above, the human health analysis assumes that for this Site, the pathway presenting the majority of the risk and likely to yield the most protective assessment of risks is consumption of contaminated fish and not dermal contact.

This does not imply that no other exposure pathways are occurring at this site, only that there is a focus on the pathway which contributes the majority of risk, the fish ingestion pathway. Other pathways clearly are occurring, such as exposure to the floodplain soils.

Toxicity

The principal source of toxicity information for use in risk assessments is U.S. EPA's Integrated Risk Information system, or IRIS. IRIS values represent consensus-based information for use agency-wide.

PCBs are classified as probable human carcinogens based on conclusive evidence in animal studies and limited evidence in human studies. Animal studies found that in several strains of mice and rats, PCBs induced hepatocellular carcinomas. In human studies, the findings suggest an increased chance of cancer via ingestion, inhalation and dermal contact. The cancer slope factor for PCBs, as obtained from IRIS is 2 mg/kg-day, for bioaccumulative pathways, such as sediment contamination and fish ingestion. A slope factor for assessing cancer risks assumes that cancer risk is probabilistic and any degree of exposure leads to some degree of risk. A slope factor relates estimated exposures to incremental lifetime cancer risks, and therefore the result is a probability of cancer over the background levels in the population. For example, a risk result of 7×10^{-4} is equivalent to saying there is an increased cancer risk at a rate of 7 in 10,000 people.

PCBs have also been reported to exert non-cancer effects. PCBs (specifically Aroclor 1254) have been shown to suppress the immune system, based on studies in rhesus monkeys. This information was used to develop a Reference Dose (RfD), which is 2×10^{-5} in IRIS. Additionally, Aroclor 1016 has been shown to exert developmental effects in monkeys (decreased birth weights). This value is 7×10^{-5}. An RfD indicates a safe level exposure, meaning that exposure at the RfD level is likely to be without an appreciable risk of deleterious effects. To assess non-cancer risks, a hazard index of the estimated exposure over the RfD is calculated. Because the RfD represents a safe level, the hazard index should be one, or less than one, to be protective of human health. The higher the hazard index, the higher the likelihood of effects.

Baseline Risks at the Site

In 1996, U.S. EPA performed a baseline risk assessment for the Site, relying on data available from WDNR on fish tissue concentrations in 1994. Table 4 lists the exposure assumptions used in the 1996 baseline risk assessment. U.S. EPA assessed in the analysis; sport fishing and subsistence fishing. The sport fishing scenario was developed to represent a mid-point or central tendency estimate of risk, and the subsistence fishing scenario was developed to represent an upper-bound estimate of risk. The sport fishing scenario variables were chosen to be reasonable, and not overly conservative in their assumptions. U.S. EPA used Great Lakes specific fish consumption information, available in West study's assessment of Michigan anglers (1989 and 1993). It was assumed that of the total amount of fish consumed, only half of the fish came from the Sheboygan River. This is accounted for in the fraction ingested term. And for the upper-bound subsistence scenario, we used a conservative estimate of all fish ingested coming from the Sheboygan River.

The baseline assessment relied upon fish data from WDNR, taken in 1994, including small mouth bass, catfish, and pike species results. Other fish data have been collected in the past, but the most recent data at the time was selected for this assessment because they were considered to be extensive and current.

Migratory fish data were also considered. Salmon and steelhead data were obtained by Blasland, Bouck, and Lee and were also presented in the Environ risk assessment. Migratory species differ from resident fish in that resident fish tend to bioaccumulate greater amounts of PCBs from this Site. These migratory fish data were considered because they are consumed by fishers of the river and would therefore help to provide the most complete account of health risks at the Site.

To best assess exposure, we consulted the Wisconsin Department of Health and Social Services (WDH) and WDNR to provide insight and information on the various exposed populations on the river. In addition, we consulted data used in developing the other assessments listed above.

Risk Characterization of Baseline Risks at the Site

The risk assessment used two sets of exposure assumptions to assess risk; in general they were developed to assess “average” fishing [central tendency] and subsistence fishing consumption. The assumptions used are listed in Table 4. In general, the subsistence consumption scenario is a very high-end exposure; an individual is getting almost all of his protein from fish, these fish are from Sheboygan only, and the person is fishing in Sheboygan over a 30 year period. However, information obtained through personal communications with WDH and in the Environ Fish Consumption Study indicate that there are some individuals in the Sheboygan River who match this exposure scenario. Alternatively, the assumptions used to shape the “average” scenario are: an individual fishing a few months a year, getting a portion (25%) of his fish from the Sheboygan River, for a period of 30 years.

Note that migratory species like salmon and steelhead were also assessed in order to give the fullest picture of risks occurring for Sheboygan fishers. It is understood that migratory species will be exposed to a wider range of sediment than a resident fish, and therefore not all contamination in these migratory species may necessarily be attributable to this particular Site.

For all species and for all exposures scenarios, cancer risks were of significant concern. Even the *central* tendency estimates of risks are of concern. The subsistence fishers, or anyone eating greater amounts of fish than the average fisher, would have even greater risks, with possible increases of an order of magnitude or more.

TABLE 4. Assumptions Used in 1996 Baseline Risk Assessment

Cancer	sport (central tendency)	subsistence (high end)	**Non-Cancer**	sport (central tendency)	subsistence (high end)
cancer slope factor	2	2	Ref. Dose	$2.0x10^{-05}$	$2.0x10^{-05}$
Body weight (kg)	70	70		70	70
Averaging time (days)	25550	25550		10950	10950
Ingestion rate (kg/day)	0.02	0.13		0.02	0.13
Fraction ingestion (%)	0.25	1		0.25	1
Absorption (%)	1	1		1	1
Exp. frequency (days/year)	365	365		365	365
Exposure duration (years)	30	30		30	30
Concentration in Fish	*species specific*	*species specific*		*species specific*	*species specific*

In order to summarize all of the risk information at the site, we compiled Table 5, to show major conclusions from several of the risk assessments done over the years (from U.S. EPA Risk Analysis 1996). Table 5 demonstrates that even with different authors and different exposure assumptions, a range of risks are present at the site due to consumption of contaminated fish.

Table 5. Comparison of Risk Estimates

Comparison of Cancer Risk Estimates from Various Assessments	U.S. EPA, 1996	Environ, 1995	GLNPO-ARCS, 1993	Baseline Assessment in RI, 1990
Key Assumptions	-19 - 65 g/day of fish -25% - 100% is from Sheboygan River -pike, catfish, salmon, steelhead, bass assessed	-percentiles of distribution of risks are shown (results of probabilistic analysis) given by each area -bass, carp, salmon and steelhead assessed	-19, 54, and 130 g/day of fish -5, 10, and 20% is from Sheboygan River -salmon, steelhead, bass and carp assessed	-20 g/day of fish -50% from Sheboygan -salmon and trout assessed

Comparison of Cancer Risk Estimates from Various Assessments	U.S. EPA, 1996	Environ, 1995	GLNPO-ARCS, 1993	Baseline Assessment in RI, 1990
Cancer risk estimates	"average" - $1x10^{-4}$ to $1x10^{-5}$ subsistence - $1x10^{-2}$ to $1x10^{-4}$	-50th ple. - $1x10^{-6}$ -70th ple. - $1x10^{-5}$ (values are for Areas 1 & 3 each)	$1x10^{-3}$ to $1x10^{-6}$	$1x10^{-2}$ to $1x10^{-3}$

Cleanup Goal Analysis - Surface Goals for the Sediment

In order to address unacceptable risks at the site, U.S. EPA calculated sediment cleanup goals, protective of human health. For this analysis, *three* types of fish consumption patterns were used. Appropriate ingestion rates for these fish consumption patterns were based on the extensive survey of Michigan anglers done by West *et al* (1989 and 1993) to develop an appropriate set of ingestion rates. For the central tendency estimate, 19 grams a day (with a frequency of 365 days per year) was used and is approximately the 50th percentile of fish consumption from the '93 West study, and is *higher* than the 50th percentiles of both the '89 study and the average of the 50th percentiles from both studies, by about 5 grams. For the reasonable maximum exposure (RME) scenario, 54 grams a day was used (with a frequency of 365 days a year) which is the 90th percentile of the '93 study and close to the 95th percentile of the average of the two studies, and much higher than the 95th percentile of the '89 study which was 39 grams a day. For the upper bound or high end consumption estimate, U.S. EPA utilized a study by Pao, that yielded a maximum value over a three day period and applied it to a year round exposure to estimate a subsistence scenario.

The fraction ingested term, or how much fish is consumed comes from the Sheboygan River, for each of the scenarios was: 25% in the central tendency scenario, 50% for the RME, and 100% for subsistence. The fraction ingested term for the central tendency and RME reflects the expectation that some anglers consume fish from water bodies other than the Sheboygan River.

An ATSDR/WDH study (May 1998) looked at where anglers caught fish in the Sheboygan area. The total number of meals estimated to be eaten by anglers from the Sheboygan River was 37 per year, while very stringent fish consumption advisories were in place for the Sheboygan River. The RME scenario estimates 43 meals a year which allows for increased fish consumption as advisories are reduced and is consistent with the potential fishery production of the Sheboygan River. The RME becomes the point of departure for risk management purposes pursuant to Agency risk guidance. See Table 6 for a complete list of exposure assumptions used in all three scenarios.

Consistent with U.S. EPA risk assessment guidance, actions at Superfund sites should be based on an estimate of the RME expected to occur under both current and future conditions. In the past, exposures generally were estimated for an average and upper-bound exposure case. The advantage of the two exposures is that they provide some measure of the uncertainty surrounding these estimates. The disadvantage of this approach is that the upper-bound estimate of exposure may be above the range of possible exposures, whereas the average estimate is lower than exposures potentially experienced by much of the population. The intent of the RME is to estimate a conservative exposure case (i.e., well above the average case) that is still within the range of possible exposures.

U.S. EPA made a conscious decision to model and be protective of the more contaminated resident fish species of smallmouth bass and carp at the site. By selecting a cleanup goal protective of bass (or carp), the cleanup will be protective of the lesser contaminated species such as walleye, trout, salmon and steelhead. This choice adds a layer of conservatism to allow for more fish consumption at the site, especially of several non-resident species. Therefore, a cleanup based on resident species may allow for possibly *more* consumption of other types of fish (greater than 54 grams per day or 43 fish meals per year from the Sheboygan River) that may occur as advisories are lifted.

Using the acceptable risk value of 10^{-6}, or 1 in 1,000,000, the range of target fish levels is quite low. The value of 0.0005 ppm in fish is protective of the upper bound estimate of subsistence fishers. This scenario relates to an individual who gets all of the protein in his diet from Sheboygan, year-round, for 70 years. For the central tendency scenario (or about half of the fishing population), the target fish concentration is 0.016 ppm. The RME scenario provides a target fish tissue level of 0.003 ppm to be protective of the 90^{th} - 95^{th} percentile of the fishing population over a 30 year period. Examples of fish cleanup goals for different risk points are a 10^{-5} level for the RME would be 0.03 ppm and a 10^{-4} level for RME would be 0.3 ppm.

To calculate a sediment cleanup goal or surface goal, these target fish tissue levels are placed into a Biota to Sediment Accumulation Factor (BSAF) equation to estimate the sediment concentrations that would meet these fish targets. The term “surface goal” is more appropriate, for the Sheboygan site, than the usual cleanup goal, because what is calculated is a surface that the fish can be exposed to that will result in the target fish tissue levels. Looking at the site, it’s necessary to calculate what the residual concentration is after dredging certain levels, or what’s left after taking out everything above a certain concentration. In the case of the Sheboygan, it’s the target surface weighted average concentration, or SWAC, of the river after remediation.

To develop cleanup goals for dioxin-like PCBs and non-dioxin-like PCBs it requires much more information on where these PCB congeners are distributed and the total organic carbon levels associated with them. This information was not available. Dioxin-like PCB cleanup goals would also require a more complex assessment of toxicity.

There were concerns with how to interpret risks generated by two separate means. One estimate is derived using a total PCB slope factor (which may include some dioxin-like congeners) and then a separate risk estimate would be generated using congener-based toxicity equivalency factors or TEFs with the dioxin slope factor. It is not clear whether risks would be over- or under-represented and given the incomplete data set, the uncertainties were considered too large to provide a clear and *quantitative* picture of dioxin-like PCBs at the site for human health.

Bioaccumulation Model

Reduced PCB levels in sediment are necessary to achieve the target fish tissue levels. To translate from the target fish tissue levels to sediment levels, a bioaccumulation model is utilized. For this site, the BSAF model was used. The methodology is the same as used in the Ecological Risk Assessment and is similar to what was used in the PRP RI/FS, except U.S. EPA risk assessments include TOC and lipid in the calculation.

Note that BSAFs were only calculated for small mouth bass and carp and not the lesser contaminated migratory species of salmon and steelhead, to provide protection for anglers who consume several different species of fish. BSAFs were calculated for small mouth bass because of their prevalence in the river and for carp as an indicator of concentrations in fish with higher lipid levels.

* Assumes a consumption scenario with 50% of the fish coming from the Sheboygan River. Assuming 100% consumption from the Sheboygan River with a contaminant reduction factor of 50% based on Great Lakes Fish Consumption Protocol results in the same fish concentration.

Table 6. Assumptions Used in Deriving Fish Tissue Levels for Sediment Cleanup Goals

Cancer (10^{-6})	sport (central tendency)	RME	subsistence (high end)	**Non-Cancer** (HI=1)	sport (central tendency)	RME	subsistence (high end)
cancer slope factor	2	2	2	Ref. Dose	$2.0x10^{-05}$	$2.0x10^{-05}$	$2.0x10^{-05}$
Body weight (kg)	70	70	70		70	70	70
Averaging time (days)	25550	25550	25550		10950	10950	10950
Ingestion rate (kg/day)	0.02	.054	0.13		0.02	.054	0.13
Fraction ingested (%)	0.25	.5*	1		0.25	.5*	1
Absorption (%)	1	1	1		1	1	1
Exp. frequency (days/year)	365	365	365		365	365	365
Exposure duration (years)	30	30	70		30	30	70
Concentration in Fish, ppm	**.016**	**.003**	**.0003**		**.28**	**.05**	**.01**

The analysis begins by calculating a site-specific BSAF using PCBs in sediment, TOC, PCBs in fish and lipid data. However, because the data in the RI/FS are given as summary statistics, the U.S. EPA could not derive its own sediment surface area weighted PCB that is normalized to TOC. This term is necessary for the BSAF model. Therefore, the SWAC derived in the RI/FS is not useable in calculating a site-specific BSAF. Because the NOAA ecological risk assessment, for the site, also developed BSAFs, U.S. EPA considered the NOAA BSAFs, and found that they were quite similar to the human health based BSAFs.

Table 7. BSAF Terms Used in Deriving a Sediment Cleanup Goal
(RME scenario shown)

Sediment Cleanup Goal -> Conc. Sediment = (TOC X Conc. Fish) / (site specific BSAF X % lipid)

	Conc. Fish [1] (ppm)	TOC [2] (%)	BSAF [3]	Lipid [4] (%)	Conc. Sed. (ppm)
Bass	0.003	5.3	4.54	0.715	**0.005**
Carp	0.003	5.3	4.62	5.927	**0.0006**

[1] The concentration in fish is shown for the RME fishing scenario, at a 10^{-6} level of risk

[2] 5.3 is the geometric mean of all the 1997 TOC data from NOAA Aquatic Ecological Risk Assessment
[3] The site-specific BSAFs are derived from the following values: RI/FS total river bed SWAC, and NOAA Risk Assessment TOC (1997), and 1994 fish data (from FIELDS database)
[4] The mean lipid percentages, for each species, in 1994 (from FIELDS database)

Note, to determine a 10^{-5} or 10^{-4} protective surface goal, simply move the decimal over; so a cleanup goal for a 10^{-4} risk for bass would be 0.5 ppm.

Table 8 shows what the PCB sediment concentrations need to be for either bass or carp consumption for various cancer and non-cancer risk levels.

Table 8. Sediment Cleanup Goal Summary Tables

Central Tendency Sport Fishing Scenario (20 g/day, 25% ingestion from Sheboygan, 30 years)	**Sediment Cleanup Goal in ppm, based on consumption of Bass**	**Sediment Cleanup Goal in ppm, based on consumption of Carp**
Cancer 10^{-6}	0.027	0.0032
10^{-5}	0.27	0.032
10^{-4}	2.7	0.32
Non-Cancer (immune effects)		
Hazard Index = 1	0.46	0.054
Hazard Index = 10	4.6	0.54

RME Scenario (54 g/day, 50% ingestion from Sheboygan, for 30 years)	**Sediment Cleanup Goal in ppm, based on consumption of Bass**	**Sediment Cleanup Goal in ppm, based on consumption of Carp**
Cancer 10^{-6}	0.005	0.0006
10^{-5}	0.05	0.006
10^{-4}	0.5	0.06
Non-Cancer (immune effects)		
Hazard Index = 1	0.085	0.01
Hazard Index = 10	0.85	0.1

High End Subsistence Scenario (130 g/day, all ingestion from Sheboygan, for 70 years)	**Sediment Cleanup Goal in ppm, based on consumption of Bass**	**Sediment Cleanup Goal in ppm, based on consumption of Carp**
Cancer 10^{-6}	0.0005	0.0001
10^{-5}	***0.005****	0.001
10^{-4}	0.05	0.01
Non-Cancer (immune effects)		
Hazard Index = 1	0.018	0.0021
Hazard Index = 10	0.18	0.021

This cleanup level is less than .011 which is generally equivalent to a cleanup goal that s generated using fish advisory goals of 50 ppb PCBs in fish tissue.

Therefore, using the cleanup goal summary tables and post-remedial risk analysis, an appropriate human health cleanup goal, based on the consumption of bass under the RME, would range from 0.005 ppm which equals a 1 in a million risk to 0.5 ppm which would equal a 1 in ten thousand risk. The 10^{-6}, or 1 in a million, risk level is the departure point for managing site risks.

Ecological Risks

Aquatic Risk Assessment

The focus of the NOAA Aquatic Risk Assessment is to estimate the present level of risk to the aquatic organisms and piscivorus birds and mammals of the Sheboygan River and Harbor from exposure to contaminated sediments, water, and biota. To estimate risk, tissue and sediment data from recent studies, including the 1994–1995 Sheboygan River food chain and sediment contaminant assessment conducted by the WDNR and data collected specifically for this aquatic risk assessment were evaluated. In addition, other relevant data collected on Sheboygan ecological communities by WDNR in recent years are included to provide an overall context for the aquatic risk assessment. Thus, the recommendations made by NOAA regarding protective sediment concentrations and future monitoring needs reflect what is currently known about the aquatic and piscivorus species in the Sheboygan River and Harbor aquatic ecosystem.

Examples of food web exposure pathways are shown in Figure 4, on page 25. Potential ecological receptor species considered for this risk assessment are benthic invertebrates (flies, beetles and clams), fish (sunfish, bass, carp, minnows, suckers, coho salmon, chinook salmon, and steelhead trout), birds (northern pintail, Northern shoveler, lesser scaup, gulls, terns, cormorants, ospreys, mallards, black ducks, Canada geese, swallows and wood ducks, kingfishers and great blue herons) and mammals (muskrat, raccoon, beaver and mink) that depend on aquatic resources of the Sheboygan River.

Contaminants considered potential chemicals of concern (COCs) included metals, PCBs, and PAHs. A contaminant is a COC if its maximum on-site concentration detected in the sediments of the Sheboygan River exceeded the sediment benchmark concentration. All potential COCs had maximum concentrations that exceeded their respective benchmarks and therefore were retained as COCs for benthic organisms. The metals included as COCs were arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc. Concentrations of PCBs and PAHs in the sediments exceeding the screening criteria were widespread and of high magnitude. Metal concentrations exceeded the benchmarks at fewer locations and at lower magnitude.

Metals, PCBs, and PAHs were also potential COCs for fish. Concentrations of metals detected in fish from the site area did not exceed the respective mean concentrations in reference area fish enough to warrant inclusion of any metals as COCs for fish. For mammals and birds, potential COCs were mercury, PCBs , and PAHs. PCBs were automatically included as COCs because of the elevated fish tissue and sediment concentrations at the study site.

Insert copy of figure 3 - aquatic food web exposure pathway

Table 9 shows the maximum concentrations of contaminants in river sediment compared to the threshold effects level.

Table 9 - Maximum Concentrations of Contaminants in River Sediment Compared to Threshold Effects Level (TEL)

		Maximum Site Concentration (ppm)				
Contaminant	TEL	River (BBL 1990)	Lower River & Harbor (BBL 1990)	Sediment Trap (WDNR 1997)	Sediment Core (WDNR 1997)	1997 NOAA Risk Assessment
Metals						
Arsenic	10.8	**23**	**20**	**25**	1.9	2.8
Cadmium	0.583	**3.2**	**3.7**	**1.2**	**2.2**	0.47
Chromium	36.3	**140**	**460**	35	28	**79**
Copper	28	**160**	**150**	**63**	**87**	**35**
Lead	37.2	**720**	**720**	**110**	**63**	**130**
Mercury	0.174	**0.42**	**0.68**	**0.79**	**0.27**	**0.20**
Nickel	19.5	**90**	**350**	**21**	N/A	19
Silver	--	0.63	0.9	Na	6	0.25
Zinc	98.1	**300**	**370**	**170**	N/A	**110**
Organic Compounds						
Total PAHs	0.264	**4.0**	**63**	**44**	**26**	**7.2**
Total PCBs	0.0316	**4,500**	**0.22**	**180**	**460**	**760**

Table 10 summarizes the contaminants of concern evaluated after the screening process.

Table 10 - Contaminants of Concern Selected for the NOAA Aquatic Risk Assessment Following Screening Procedures

Receptor of Concern	**PCBs**	**PAHs**	**Metals**
Benthic Invertebrates	✓	✓	✓
Fish	✓	✓	
Birds	✓		
Mammals	✓		

The Sheboygan River and Harbor ecosystem includes a diverse range of species and functions, a subset of which was evaluated in the NOAA risk assessment. Since the risk assessment could not evaluate all species and all possible toxicological effects, important and representative species were selected as surrogates for the ecosystem and ecologically significant effects were emphasized. Based upon a review of the NOAA Aquatic Risk Assessment, PCB-contaminated sediment pose a risk to fish and wildlife. U.S. EPA has analyzed the ecological risk, in consultation with the natural resource trustees. A sediment cleanup goal between 0.05 ppm and 1.0 will protect fish and wildlife. The 0.05 ppm level represents the No Observed Adverse Effects Level (NOAEL) for the mink while the 1.0 ppm represents the Lowest Observed Adverse Effects Level (LOAEL) for the Heron. The Superfund program strives for clean up targets between the NOAEL and LOAEL, which is similar to the approach to the human health target range of 1×10^{-4} to $1 \times 10^{-6.}$ Table 11 shows the NOAEL and LOAEL for fish, heron and mink.

Table 11 - Total PCB Protective Sediment Concentrations (ppm)

	Fish		Heron		Mink	
	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Range	3.7 - 16.0	6.0 - 25.0	0.1 - 0.7	0.2 - 1.0	0.05 - 0.7	0.7 - 1.5

Terrestrial Assessment

The floodplain terrestrial ecological risk assessment (TERA), part of the risk assessment efforts at the Sheboygan River and Harbor site, is a companion to the aquatic ecological risk assessment (AERA 1998). The terrestrial wildlife present along most of the upper Sheboygan River would be species adapted to mixed open, shrub, and wooded habitats that are tolerant of human disturbance. Species dependent on forested habitat may be present in the approximately 35-acre wooded “peninsula” formed by a clockwise loop of the river. This forested area is less disturbed by humans because it is surrounded by the river on three sides with no easily fordable approaches, and is backed by a steep slope on the fourth side.

Birds that include earthworms in their diets (vermivores) are of particular concern, since this is the probable pathway of greatest exposure to floodplain PCBs. Vermivorous robins and eastern bluebirds are present along the Sheboygan River in open and mixed habitats. Ovenbirds, another vermivorous species, nest in forested habitats. Ring-billed gulls also include worms in a highly varied diet, and forage far inland. Many species of birds feed on terrestrial invertebrates (beetles and other insects, spiders, etc.), such as brown thrashers, wrens, killdeer (especially beetles), young wood duck, blue jays, northern flickers (especially ants), common grackles (also steal food from robins), and spotted sandpipers (Bellrose 1976; Johnsgard 1981; Ehrlich, et al. 1988). These species could be exposed to soil PCBs through their prey (although probably not as much exposure as vermivores), but also may opportunistically include earthworms in their diets when readily available.

The TERA was based on PCB congener-specific analyses of co-located earthworm and soil samples collected November 2 - 3, 1997. The worm congener data were extrapolated to robin egg concentrations, which were compared with egg toxicity data on three bases: total PCBs, specific congeners, and dioxin toxic equivalents. The egg HQs, based on hatchability and malformations, ranged from 13 to 48 for no observed adverse effect concentrations (NOAEC), and from 6 to 22 for lowest observed adverse effect concentrations (LOAEC) for the central tendency scenarios of the various approaches. For the 95 percent upper confidence limit scenarios, NOAEC-HQs ranged from 22 to 80, and LOAEC-HQs ranged from 9 to 36. HQs were also developed on the basis of dose to adult birds, but the results varied by as much as an order-of-magnitude: central tendency 30 - 280 NOAEL-HQs and 3 - 120 LOAEL-HQs.

Since egg-based risk estimates were less variable than oral dose-based estimates, the egg bioaccumulation models were used to back-calculate ecologically protective earthworm concentrations separately for total PCBs and on a congener-specific basis. Ecologically-protective soil preliminary remedial goals (PRGs) were back-calculated from earthworms by use of site-specific soil-to-earthworm bioaccumulation factors (BAFs). Soil PRGs are 1 - 2 ppm total PCBs based on NOAECs, and 3 - 5 ppm based on LOAECs.

<u>TERA Goals</u>

There are two main goals of an ecological risk assessment (ERA): 1) to determine whether harmful effects are likely for wild animals or plants, and 2) if there is risk, to calculate a protective remedial goal that would reduce the risk to wild animals or plants. Only wildlife is considered, domesticated animals or plants are excluded from ERA. The process for performing an ERA is described in the Superfund guidance for ecological risk assessment (U.S. EPA 1997).

<u>Chemicals of Concern</u>

The TERA focused solely on PCBs because they were previously identified as a potential COC in floodplain soils. Chlorinated dioxins and dibenzofurans were not included because they were shown to make only a minor contribution (less than 10 percent) to the toxicity of fish contaminant loads in the Sheboygan River (AREA 1998). The PCBs in the upper river floodplain were deposited by floods, so the contaminant composition of the upper floodplain soils should be similar to that of the river sediments. Exclusion of dioxins and furans may result in a modest underestimation of floodplain contaminant risks.

<u>Assessment Endpoint</u>

The assessment endpoint for the TERA is reproductive performance in terrestrial vermivorous and insectivorous species (feeds on earthworms and insects, respectively). The endpoint selection was based on fate and transport of PCBs, bioaccumulation potential, and likely ecotoxicological effects.

Measurement Endpoint

The measurement endpoint is modeled reproductive performance in robins. Robins feed predominantly on insects, earthworms and other invertebrates during the breeding and nesting season, and therefore should be representative of a variety of birds that have similar diets. Woodcock would be expected to show greater risk than robins since they feed almost exclusively on earthworms (earthworms accumulate higher levels of PCBs from soil than do most insects). However, U.S. EPA and WDNR biologists agreed that the habitats along the floodplain sections with elevated soil PCBs are not favorable for woodcock or snipe. Robins were selected as reasonably representative of potential avian receptors in the floodplain section under consideration.

Although mammals were not considered in this risk assessment, mammals that feed on worms for much (shrews, moles) or part (raccoons, skunks, opossum) of their diets may also be at risk (Whitaker and Hamilton 1998). Surprisingly, even fox may eat substantial numbers of worms when available (MacDonald 1980). The vermivorous northern short-tailed shrew and star-nosed mole are likely present at Sheboygan along with the remaining aforementioned mammals.

The PCB dose to robins feeding in the contaminated floodplain was calculated for consumption of three broad categories of prey: earthworms, hard-bodied invertebrates (beetles), and soft-bodied invertebrates (other than earthworms) (Figure 5). Several other potential exposure pathways were not included in the model.

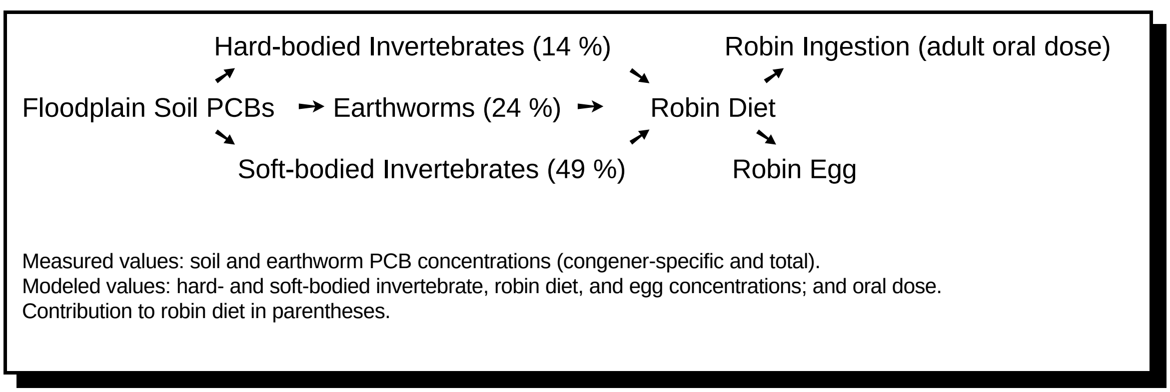


Figure 5- Robin PCB Exposure Model, Sheboygan River Floodplain, WI

Risk Summary

The results of the modeling and risk characterization approaches utilized in the TERA consistently indicated increased risks of adverse reproductive effects in robins foraging in contaminated sections of the Sheboygan River floodplain. Risk estimates for egg concentrations were less variable than for oral doses to adult robins. Egg NOAEC- and LOAEC-based HQs ranged from 10 to 50, and from 6 to 20, respectively, for central tendency exposure scenarios. HQs ranged as high as 40 and 80, based on NOAEC and LOAEC, respectively, for the 95 percent upper confidence limit (95 percent UCL) exposure scenarios. In contrast, adverse effects are unlikely in the reference location where the egg HQs were two orders of magnitude less than the level of concern.

Ecologically Protective Soil Preliminary Remedial Goals (PRGs)

Egg-based risk estimates were much less variable than oral dose-based estimates, so the egg model was used to back-calculate soil ecologically protective remedial goals (PRGs). PRGs were calculated on the basis of total PCBs, and two congener-specific models that differed in the biomagnification factors used to estimate egg congener concentration from the robin dietary concentration. We did not use dioxin toxic equivalents to back-calculate soil PRGs because congener-specific risk estimates were available for the congeners that predominantly contribute to the dioxin toxic equivalents. The risk estimates based on direct assessment of congener-specific toxicity were considered more reliable than risk estimates based on indirect assessment of the relative toxicities of PCB congeners compared to dioxin. PRGs are shown in Table 12.

TERA Risk Summary

The total PCB-based and congener-specific-based PRGs indicate that adverse effects are unlikely where soil PCB concentrations are at or below 1 - 2 ppm. The congener-specific LOAEC-based soil PRGs range from 3 to 5 ppm, depending on the biomagnification model, but the results bracket the total PCB LOAEC-based PRG of 4 ppm. This indicates that adverse effects may occur where soil PCB concentrations exceed 3 - 5 ppm.

TERA Risk Summary Adjusted for Soil PRGs

The soil PRGs were adjusted for foraging area use based on the floodplain delineation sampling Tecumseh performed in 1992 (post-phases I and II) (ASRI 1995). Two extrapolations were performed: one for the robin foraging range during the time they are feeding nestlings, and the second for the foraging range during the time they are caring for fledglings. The NOAEC-based PRG did not change, but the LOAEC-based PRG increased to 9 ppm for the fledgling stage. Therefore, robins with fledgling stage foraging areas bordering the Sheboygan River are at risk of reproductive impairment where the floodplain soil mean PCB concentration exceeds 9 ppm.

Surface Weighted Average Concentration performed on a scale appropriate for robin foraging areas indicated that remediation of floodplain soil equal to or greater than 10 ppm PCB should be protective, that is, it should result in foraging SWAC at or below 5 ppm, with few exceptions. Remediation of floodplain soil PCB concentrations equal to or greater than 50 ppm may be appropriate in select areas of high quality forested habitat on the basis of a risk management decision to balance risk reduction with habitat preservation, but it is not justifiable on the basis of SWAC when averaged over a scale appropriate for foraging robins.

Table 12 - Ecologically Protective Soil Preliminary Remedial Goals (PRGs), Sheboygan River Floodplain, WI.

Toxicity Basis	NOAEC-based PRG	LOAEC-based PRG
	(ppm total PCBs)	
Total PCBs [a]	1	4
Congener-specific [b]	1.5	3
Congener-specific [c]	2	5
Area Use Adjusted [d]	no change	4 - 9

a) Modeled with gull diet-to-egg BMF (Braune and Norstrom 1989).
b) Modeled with tern BMF (Kubiak, et al. 1989).
c) Modeled with gull BMF (Norstrom pers. comm. in Hoffman, et al. 1996).
d) Combined results for nestling-stage and fledgling-stage foraging areas, respectively.

BMF - Bio-magnification Factor

Risk Summary

Table 13 summarizes the PCB target concentrations for human health and ecological risks.

Table 13 - Sheboygan River & Harbor PCB Target Sediment & Soil SWAC Concentration Ranges (ppm)

Human Health (10^{-6} to 10^{-4})	Ecological Health (NOAEL to LOAEL)	
Sediments	Sediments	Floodplain Soil
0.005 - 0.5	0.05 to 1.0	0.05 to 10

H. REMEDIATION OBJECTIVES

There are three primary remediation objectives.

1. Protect human health and the environment from imminent and substantial endangerment due to PCBs attributed to the Site.

> To achieve this remediation objective, PCB-contaminated soft sediment will be removed so that the entire river will reach an average PCB sediment concentration of 0.5 ppm or less over time. An average PCB sediment concentration of 0.5 ppm results in an excess human health carcinogenic risk of 1.0×10^{-4}, or less over time, through the consumption of PCB-contaminated fish.
>
> Based on site specific biota to sediment accumulation factors, the corresponding PCB tissue levels for resident fish are:
>
> > **Sport Fish**
> > Small Mouth Bass: 0.31 ppm, Walleye: 0.63, Trout: 0.09 ppm
> >
> > **Bottom Feeders**
> > Carp: 2.58 ppm, Catfish: 2.53 ppm
>
> Achievement of the soft sediment concentration and fish tissue concentrations, over time, will be reevaluated every five years after completion of the remedy.
>
> Reaching the river sediment objective of a 0.5 ppm average PCB concentration requires different approaches for the Upper, Middle, and Lower River, and the Inner Harbor because of the way sediment is distributed and whether the contaminated sediment is considered mobile given the dynamics of that specific river component.
>
> For PCB-contaminated floodplain areas, this remediation objective will be achieved by removing sufficient contaminated soil to reach an average PCB soil concentration of 10 ppm or less. The areas of soil remediation will be backfilled to its previous grade and re-vegetated to prevent future soil erosion and siltation in the river. With respect to PCB-contaminated ground-water or other potential sources near Tecumseh's Sheboygan Falls plant, the remediation objective will be to investigate and stop all additional PCB sources to the river system.

2. Mitigate potential PCB sources to the Sheboygan River/Harbor system and reduce PCB transport within the river system.

As mentioned previously, additional investigations will occur to determine the effects of PCB-contaminated ground-water or possible additional PCB sources from Tecumseh's Sheboygan Falls plant. In addition, because of the dynamic nature of the Upper River and Middle River segments of the Sheboygan River, PCB-contaminated soft sediment deposits will be removed to achieve an average soft sediment deposit SWAC of 0.5 ppm. This includes PCB mass removal of 88% in the Upper River. Lastly, PCB-contaminated floodplain soil may act as a future source to the river during high flow events, therefore, PCB-contaminated soil will be removed in seven areas. Since some of the areas within these floodplain soils may be considered high-quality habitat, the removal of PCB-contaminated soil will be balanced with keeping high-quality habitat intact to the extent practicable.

3. Remove and dispose of Confined Treatment Facility (CTF) / Sediment Management Facility (SMF) sediments and previously armored/capped PCB-contaminated soft sediment deposits.

The CTF and SMF were not designed to be permanent structures. As part of the remediation of the site, sediments in the CTF and SMF will be disposed of in a WDNR approved off-site landfill. In doing so, this action will reduce the long-term management and maintenance requirements for the site. In addition, because recent information collected by Tecumseh indicates that there may be continuing discharges of PCBs from Area 1 and because of concerns about the effectiveness of all of the previously armored/capped soft sediment deposits, the armored/capped sediment deposits, including Area 1, will be removed.

I. DESCRIPTION OF ALTERNATIVES

Based on RI/FS reports and previous investigations, U.S. EPA evaluated several alternatives to address contamination in and near the Sheboygan River and Harbor. Because the level of contamination varies in different parts of the river, the proposed cleanup plan has five components: 1) upper river sediment; 2) middle river sediment; 3) lower river and harbor sediment; 4) floodplain soil adjacent to the river; and 5) ground water near Tecumseh's Sheboygan Falls plant. A long-term monitoring plan which includes 30 years of fish sampling will be implemented for the entire river and harbor.

In evaluating the alternatives, U.S. EPA considered the level of protection that would satisfy the concern of the natural resource trustees that future natural resource injuries be minimized. The natural resource trustees have concluded that, given the proposed cleanup level of 0.5 ppm PCBs in soft sediment and 10 ppm PCBs in floodplain soil, the natural resources will continue to incur injuries. These additional injuries will be factored into the resolution of the natural resource liability. U.S. EPA also considered the extent to which implementing the alternatives could bring about additional adverse impacts to natural resources.

UPPER RIVER SEDIMENT

Forty-six separate deposits of PCB-contaminated soft sediment have been identified in the Upper River. Because of recent flooding on the Sheboygan River, the location and size of some of these deposits may have changed since the deposits were originally identified. U.S. EPA's goal is to reduce imminent and substantial threats to human health and the environment by removing PCB-contaminated sediment in these soft sediment deposits. Three alternatives were developed to address Upper River sediment. However, there are six sub-alternatives, with varying amounts of sediment removal, under the Alternative #3. Each remedy alternative shows the capital and operation and maintenance (O&M) costs.

Alternative 1: No Action

Estimated Capital Cost: $0 million
Annual O & M Cost: $0
Total Present Value (7% discount rate): $0 million.
Estimated Time to Implement: 0 months

The NCP requires the no-action alternative. Its purpose is to allow comparison of alternatives to the conditions that currently exist and that will likely exist in the future. Under this alternative, no further action would be taken in the Upper River beyond dredging and armoring already completed. Fish and waterfowl consumption advisories would remain in place until monitoring indicates they can be dropped.

Alternative 2: Natural Recovery/Monitoring and Disposal of CTF & SMF Sediments

Estimated Capital Cost: $2.6 million
Annual O & M Cost: $ 140,000 or 147,000
Duration of O & M: 30 years
Total Present Value (7% discount rate): $4.5 million.
Estimated Time to Implement: 2 months

Under this alternative, sediment monitoring would be done every 5 years and annual fish monitoring would take place for 30 years. Periodic maintenance of already-capped areas would also continue for 30 years. Contaminated sediment stored at the Tecumseh plant would be disposed of in a WDNR-approved landfill.

Alternative 3: Sediment Removal

Six Upper River sediment removal sub-alternatives have been developed. The sub-alternatives vary in terms of the amount of sediment and PCBs that would be removed and build upon each other. For example, sediments removed under Alternative 3-II include sediments removed under Alternative 3-I. Sediments removed under Alternative 3-III include sediments removed under Alternative 3-II which include sediments under Alternative 3-I. The cumulative PCB percentages described in the FS include PCBs removed as part of the 1991 removal action. The use of these figures may cause people to assume that more contaminated sediment is being removed then would actually occur under the remedial action. PCB percentages in the following six alternatives represent the percentage of the <u>remaining</u> PCBs in the Upper River after dredging with 90 percent efficiency.

Future removal activities will likely use mechanical dredging to excavate the contaminated sediment, however, the actual removal technology used will be determined during the design phase of the site. The contaminated sediment will be dewatered, stabilized and placed in either a solid waste landfill or licensed hazardous waste landfill depending on the level of PCB concentration. Contaminated sediment stored at the Tecumseh plant would be disposed of in a licensed hazardous waste landfill due to its high level of contamination.

<u>Alternative 3-I</u>

Estimated Capital Cost: $10.7 million
Annual O & M Cost: $ 140,000 or 175,000
Duration of O & M: 30 years
Total Present Value (7% discount rate): $11.1 million.
Estimated Time to Implement: 16 months

Removal of approximately 5,400 cubic yards of sediment containing 34 percent of the Upper River's PCBs. U.S. EPA estimates that removal of 34 percent of the remaining PCBs in the Upper River will be necessary to achieve a PCB soft sediment deposit SWAC of 2.9 ppm for the Upper River. Under this alternative, the areas capped/armored during ASRI/removal action activities would be removed. Removal of sediment under this alternative would require obtaining access at two points along the Upper River. Annual fish sampling will occur until fish consumption advisories are lifted. Sediment samples will be taken at least once every five years, after dredging is complete, to document natural processes.

<u>Alternative 3-II</u>

Estimated Capital Cost: $14.2 million
Annual O & M Cost: $ 140,000 or 175,000
Duration of O & M: 30 years
Total Present Value (7% discount rate): $13.8 million.
Estimated Time to Implement: 21 months

Removal of approximately 7,500

cubic yards of sediment containing 62 percent of the Upper River's PCBs. U.S. EPA estimates that removal of 62 percent of the remaining PCBs in the Upper River will be necessary to achieve a PCB soft sediment deposit SWAC of 2.8 ppm for the Upper River. Under this alternative, the areas capped/armored during ASRI/removal action activities would be removed. Removal of sediment under this alternative requires four access points along the Upper River. Annual fish sampling will occur until fish consumption advisories are lifted. Sediment samples will be taken at least once every five years, after dredging is complete, to document natural processes.

<u>Alternative 3-III</u>

Estimated Capital Cost: $16.1 million
Annual O & M Cost: $ 140,000 or 175,000
Duration of O & M: 30 years
Total Present Value (7% discount rate): $15.2 million.
Estimated Time to Implement: 26 months

Removal of approximately 8,900 cubic yards of sediment containing 72 percent of the Upper River's PCBs. U.S. EPA estimates that removal of 72 percent of the remaining PCBs in the Upper River will be necessary to achieve a PCB soft sediment deposit SWAC of 2.6 ppm for the Upper River. Under this alternative, the areas capped/armored during ASRI/removal action activities would be removed. Removal of sediment under this alternative requires five access points along the Upper River. Annual fish sampling will occur until fish consumption advisories are lifted. Sediment samples will be taken at least once every five years, after dredging is complete, to document natural processes.

<u>Alternative 3-IV</u>

Estimated Capital Cost: $22.2 million
Annual O & M Cost: $ 140,000 or 175,000
Duration of O & M: 30 years
Total Present Value (7% discount rate): $19.1 million.
Estimated Time to Implement: 42 months

Removal of approximately 13,800 cubic yards of sediment containing 78 percent of the Upper River's PCBs. U.S. EPA estimates that removal of 78 percent of the remaining PCBs in the Upper River will be necessary to achieve a PCB soft sediment deposit SWAC of 2.0 ppm for the Upper River. Under this alternative, the areas capped/armored during ASRI/removal action activities would be removed. Removal of sediment under this alternative requires six access points along the Upper River. Annual fish sampling will occur until fish consumption advisories are lifted. Sediment samples will be taken at least once every five years, after dredging is complete, to document natural processes.

Alternative 3-IV-A

This alternative, developed by U.S. EPA, represents a variation of the removal alternatives presented in the FS.

Estimated Capital Cost: $30.6 million
Annual O & M Cost: $140,000 or $175,000
Duration of O & M: 30 years
Total Present Value (7% discount rate): $23.8 million.
Estimated Time to Implement: 60 months

Removal of approximately 20,774 cubic yards of sediment containing 88 percent of the Upper River's PCBs. U.S. EPA estimates that removal of 88 percent of the remaining PCBs in the Upper River will be necessary to achieve a PCB soft sediment deposit SWAC of 0.5 ppm for the Upper River. Under this alternative, the areas capped/armored during ASRI/removal action activities would be removed. Area 1, which was capped/armored during ASRI/removal action activities, will be removed. The FS assumes that this deposit will remain in place, however, recent information collected by Tecumseh indicates that there may be continuing discharges of PCBs from this area. Removal of sediment under this alternative requires five access points along the Upper River. Annual fish sampling will occur until fish consumption advisories are lifted. Sediment samples will be taken at least once every five years, after dredging is complete, to document natural processes and to ensure that over time the entire river will reach an average PCB sediment concentration of 0.5 ppm, or less, and that over time fish consumption advisories can be phased out.

Alternative 3-V

Estimated Capital Cost: $33.6 million
Annual O & M Cost: $140,000 or 175,000
Duration of O & M: 30 years
Total Present Value (7% discount rate): $25.6 million.
Estimated Time to Implement: 65 months

Removal of approximately 22,500 cubic yards of sediment containing 90 percent of the Upper River's PCBs. U.S. EPA estimates that removal of 90 percent of the remaining PCBs in the Upper River is expected to achieve a PCB soft sediment deposit SWAC of 0.4 ppm for the Upper River.

Under this alternative, the areas capped/armored during ASRI/removal action activities would be removed. Removal of sediment under this alternative requires six access points along the Upper River. Annual fish sampling will occur until fish consumption advisories are lifted. Sediment samples will be taken at least once every five years, after dredging is complete, to ensure that over time the entire river will reach an average PCB sediment concentration of 0.4 ppm, or less, and that over time fish consumption advisories can be phased out.

Middle River Sediment

Surface sediments in the Middle River generally contain relatively low levels of PCBs and some heavy metals. Using the 1987 RI data, the overall soft sediment SWAC for the Middle River is currently 1.5 ppm but sediment PCB levels have been found at levels as high as 37 ppm. Three alternatives were developed for the Middle River.

<u>Alternative 1: No Action</u>

Estimated Capital Cost: $0
Annual O & M Cost: $0
Estimated Time to Implement: 0 years

This alternative is similar to the no-action alternative for the Upper River; nothing would be done in the Middle River under this alternative. Fish and waterfowl consumption advisories would remain in place until monitoring indicates they can be dropped.

<u>Alternative 2: Characterization and Monitored Natural Processes</u>

Estimated Capital Cost: $0
Annual O & M Cost: $140,000 or 175,000
Duration of O & M: 30 years
Total Present Value (7% discount rate): $2.0 million.
Estimated Time to Implement: 0 months

Due to the presence of PCB contamination and the dynamic nature of the river, this component of the river will be re-characterized to establish an accurate picture of contaminant distribution in soft sediment and to determine if removal of PCB-contaminated soft sediment is warranted. In addition, re-characterization will become the baseline for evaluating natural processes trends and tracking soft sediment concentrations toward a soft sediment SWAC of 0.5 ppm for the Middle River over time. A monitoring program would be implemented to gauge the condition of the river and potential human health impacts over time. Long-term monitoring will provide valuable information on changing conditions that may warrant removal of PCB-contaminated sediment. Annual fish sampling will be required until fish consumption advisories are lifted. Sediment samples will be required at least once every five years to document natural processes and ensure that, over time, the Middle River will reach an average PCB sediment concentration of 0.5 ppm, or less. ***This alternative was not considered in the FS and was developed by the U.S. EPA.***

<u>Alternative 3: Characterization, Sediment Removal and Monitored Natural Processes</u>

Estimated Capital Cost: $18.1 million
Annual O & M Cost: $140,000 or 175,000
Duration of O & M: 30 years
Total Present Value (7% discount rate): $13.1 million
Estimated Time to Implement: 49 months

Due to the presence of PCB contamination and the dynamic nature of the river, this component of the river will be re-characterized to determine what soft sediment deposits will be removed to achieve a soft sediment SWAC of 0.5 ppm for the Middle River upon completion of the remedial action. Using the 1987 RI data, the overall soft sediment SWAC for the Middle River is currently 1.5 ppm. Based on this information 13,684 cubic yards of PCB-contaminated sediment would be removed to achieve a soft sediment SWAC of 0.5 ppm for the Middle River.

A monitoring program would be implemented to gauge the condition of the river and potential human health impacts over time. Long-term monitoring will provide valuable information on changing conditions that may warrant removal of PCB-contaminated sediment. Annual fish sampling will occur until fish consumption advisories are lifted. Sediment samples will be taken at least once every five years to document natural processes and ensure that over time the Middle River will remain at an average PCB sediment concentration of 0.5 ppm, or less. ***This alternative was not considered in the FS and was developed by the U.S. EPA.***

Lower River and Inner Harbor Sediment

Seven alternatives were developed for the Lower River and Inner Harbor. Alternatives 3, 4 and 6 were developed by U.S. EPA and are not included in the FS. All alternatives include maintaining the existing north and south outer harbor breakwalls. The outer harbor breakwalls protect Inner Harbor sediment from Lake Michigan wave action and keep the highest levels of contaminated PCB sediment at depth.

Alternative 1: No Action

Estimated Capital Cost: $0
Annual O & M Cost: $0
Estimated Time to Implement: 0 years

In this alternative nothing would be done in the Lower River and Inner Harbor. Fish and waterfowl consumption advisories would remain in place until monitoring indicates that they can be dropped.

Alternative 2: Monitored Natural Processes

Estimated Capital Cost: $0
Annual O & M Cost: $ 201,300 or 326,000
Duration of O & M: 30 years
Total Present Value (7% discount rate): $3.1 Million
Estimated Time to Implement: 0 months

Annual fish and sediment monitoring will occur until fish and waterfowl advisories are lifted. Fish and waterfowl consumption advisories will remain in place until monitoring indicates that they can be dropped. The outer harbor breakwalls will be maintained to keep contaminated sediments at depth.

Alternative 3: Inner Harbor Sediment Trap

Estimated Capital Cost: $10.4 million
Annual O & M Cost: $ 201,300 or 237,000
Duration of O & M: 30 years
Total Present Value (7% discount rate): $9.3 Million
Estimated Time to Implement: 4 months

Approximately 27,000 cubic yards of contaminated sediment will be excavated to create a sediment trap. The sediment trap will be installed to capture contaminated sediment and keep it from entering Lake Michigan. The dredged sediment will be dewatered, stabilized, and disposed of in either a WDNR-approved in-state landfill or out-of-state hazardous waste landfill depending on its PCB concentration. Any areas of Lower River and Inner Harbor that are excavated will be backfilled with clean sediment in a manner to minimize resuspension or disturbance of contaminated sediments. Annual fish sampling will occur until fish consumption advisories are lifted. Sediment samples will be taken at least once every year to document natural processes and ensure that over time the Lower River and Inner Harbor reach an average PCB sediment concentration of 0.5 ppm, or less. Fish and waterfowl consumption advisories will remain in place until monitoring indicates that they can be dropped. The outer harbor breakwalls will be maintained to keep contaminated sediments at depth. ***This alternative was not considered in the FS and was developed by the U.S. EPA.***

<u>Alternative 4: Lower River and Inner Harbor Sediment Removal Subject to Natural and Recreational Disturbances</u>

Estimated Capital Cost: $12.1 million *Annual O & M Cost: $201,300 or 237,000* *Duration of O & M: 30 years* *Total Present Value (7% discount rate): $10.0 Million* *Estimated Time to Implement: 2 years*

Under this Alternative, U.S. EPA estimates that 53,000 cubic yards of contaminated sediment, in the Inner Harbor, will be dredged so that the Lower River and Inner Harbor surface sediments will achieve a PCB concentration of 0.5 ppm, or less, on average over time. Prior to any dredging, characterization of the Inner Harbor is necessary to delineate PCB concentrations at depth. Any dredged sediment would be dewatered, stabilized, and disposed of in either a WDNR-approved in-state landfill or out-of-state hazardous waste landfill depending on its concentration. Annual bathymetric surveys will be required to assess sediment profile changes and determine if buried PCB-contaminated sediment is vulnerable to disturbance and release.

Like the Inner Harbor, portions of the Lower River may contain contaminated sediment that will impair surface sediments from achieving a 0.5 ppm average over time. Characterization of the sediment will be conducted to determine if any of these contaminated sediment areas currently exist. Contaminated sediment with concentrations greater than 26 ppm within the top 2 feet will be removed. Similar to the Inner Harbor, annual bathymetric surveys will be required to assess sediment profile changes and determine if buried contaminated sediment is vulnerable to release. Any areas of Lower River and Inner Harbor that are excavated will be backfilled with clean sediment in a manner to minimize resuspension or disturbance of remaining contaminated sediments.

Annual fish samples will taken until fish consumption advisories are lifted. Sediment samples will be taken at least once every five years to document natural processes and ensure that over time the Lower River and Inner Harbor reach an average PCB sediment concentration of 0.5 ppm, or less. Fish and waterfowl consumption advisories will remain in place until monitoring indicates they can be dropped. The outer harbor breakwalls will be maintained to keep contaminated sediments at depth. ***This alternative was not considered in the FS and was developed by the U.S. EPA.***

<u>Alternative 5: Inner Harbor Sediment Capping</u>

The Inner Harbor will be covered with a geotextile fabric, 20 inches of course-grained stone, and 12 inches of 6- to 8-inch diameter stone. Annual fish sampling will occur until fish consumption advisories are lifted. Sediment samples will be taken at least once every five years to document natural processes and ensure that over time the Lower River and Inner Harbor reach an average PCB sediment concentration of 0.5 ppm, or less. The outer harbor breakwalls will be maintained to keep contaminated sediments at depth.

Estimated Capital Cost: $12.9 million
Annual O & M Cost: $ 187,300 or 312,300 or 487,300
Duration of O & M: 30 years
Total Present Value (7% discount rate): $10.8 Million
Estimated Time to Implement: 1 year

<u>Alternative 6: Inner Harbor Surface Sediment Removal</u>

Under this alternative, the top 2 feet, approximately 117,000 cubic yards, of contaminated sediment will be dredged from the harbor and replaced with clean sediment. The dredged sediment will be dewatered, stabilized, and disposed of in a WDNR-approved in-state landfill. Any areas of Lower River and Inner Harbor that are excavated will be backfilled with clean sediment in a manner to minimize resuspension or disturbance of remaining contaminated sediments.

Estimated Capital Cost: $21.6 million
Annual O & M Cost: $201,300 or $237,000
Duration of O & M: 30 years
Total Present Value (7% discount rate): $14.6 Million
Estimated Time to Implement: 4 years

Annual fish samples will be taken until fish consumption advisories are lifted. Sediment samples will be taken at least once every five years to document natural processes and ensure that over time the Lower River and Inner Harbor reach an average PCB sediment concentration of 0.5 ppm, or less. Fish and waterfowl consumption advisories will remain in place until monitoring indicates they can be dropped. The outer harbor breakwalls will be maintained to keep contaminated sediments at depth. ***This alternative was not considered in the FS and was developed by the U.S. EPA.***

<u>Alternative 7: Inner Harbor Sediment Removal - Complete Excavation</u>

Estimated Capital Cost: $339.2 million
Annual O & M Cost: $75,000 or $187,300
Duration of O & M: 30 years
Total Present Value (7% discount rate): $169.3 Million
Estimated Time to Implement: 6 years

This alternative includes the removal of approximately

960,000 cubic yards of sediment between the Pennsylvania Avenue bridge and the mouth of the Inner Harbor. The dredged sediment will be dewatered, stabilized, and disposed of in either a WDNR-approved in-state landfill or out-of-state hazardous waste landfill. Annual fish samples will be taken until fish consumption advisories are lifted. Sediment samples will be taken at least once every five years to document natural processes and ensure that over time the Lower River and Inner Harbor reach an average PCB sediment concentration of 0.5 ppm, or less. Outer harbor breakwall maintenance will continue until all the Inner Harbor sediment is removed. Fish and waterfowl consumption advisories would remain in place until monitoring indicates they can be dropped.

Floodplain Soil

There are four alternatives for cleaning up contaminated floodplain adjacent to the river:

<u>Alternative 1: No Action</u>

Under this alternative, nothing will be done and floodplain soil will remain in its current state.

Estimated Capital Cost: $0
Annual O & M Cost: $0
Estimated Time to Implement: 0 months

<u>Alternative 2: Bank Soil Stabilization</u>

The upper 12 inches of soil will be removed from the river bank (from the waterline to where mature vegetation starts). Areas susceptible to erosion will be rehabilitated to prevent erosion.

Estimated Capital Cost: $644,000
Annual O & M Cost: $6,000
Duration of O & M: 30 years
Total Present Value (7% discount rate): $632,000
Estimated Time to Implement: 12 months

<u>Alternative 3: Removal of Soil Containing More than 50 ppm of PCBs</u>

Floodplain soil containing PCB concentrations greater

Estimated Capital Cost: $1.9 million
Annual O & M Cost: $15,600
Duration of O & M: 30 years
Total Present Value (7% discount rate): $1.8 Million
Estimated Time to Implement: 12 months

than 50 ppm will be removed and disposed of off site at a licensed hazardous waste landfill. Areas of excavation will be re-vegetated.

Alternative 4: Removal of Soil Containing More than 10 ppm of PCB

Estimated Capital Cost: $4.7 million
Annual O & M Cost: $29,800
Duration of O & M: 30 years
Total Present Value (7% discount rate): $4.5 Million
Estimated Time to Implement: 30 months

Floodplain soil containing PCB concentrations greater than 10 ppm will be removed and disposed of off site at a licensed hazardous waste landfill. However, in some areas, contaminated soil with more than 10 ppm may be left in place to prevent negative impacts to high-quality habitat. Areas of excavation will be re-vegetated.

Ground -Water and Additional PCB Sources

Ground-water at Tecumseh's Sheboygan Falls plant contains elevated levels of PCBs. The four alternatives for addressing PCB-contaminated ground water are:

Alternative 1: No Action

Estimated Cost: $0
Annual O & M Cost: $0
Estimated Time to Implement: 0 Years

Under this alternative, no action will be taken.

Alternative 2: Investigation/Source Identification and Control

Estimated Capital Cost: $313,000
Annual O & M Cost: $21,000
Duration of O & M: 30 years
Total Present Value (7% discount rate): $594,000
Estimated Time to Implement: 12 months

Ground-water investigations will be required to determine the extent of the PCB contamination and the potential sources of the contamination. Following this investigation, a decision will be made regarding potential cleanup options including the potential for relying on natural attenuation. However, if natural attenuation is inappropriate to clean up ground-water, Alternative 3 will be selected.

Alternative 3: Collection Trench and Treatment

Estimated Capital Cost: $ 1.0 million
Annual O & M Cost: $37,000
Duration of O & M: 30 years
Total Present Value (7% discount rate): $1.5 Million
Estimated Time to Implement: 12 months

This alternative includes collecting ground-water in a ground-water collection trench, pumping out the water and treating it in the existing water treatment facility at the plant. Approximately eight additional ground-water monitoring wells will be installed. This alternative also requires an investigation of hydrogeologic conditions at the plant.

Alternative 4: Facility Perimeter Cut-off Wall

Estimated Capital Cost: $3.1 million
Annual O & M Cost: $37,000
Duration of O & M: 30 years
Total Present Value (7% discount rate): $3.6 Million
Estimated Time to Implement: 24 months

Under this alternative, a wall will be built in the ground around the plant to isolate the contaminated ground water. Five wells will be installed to pump the water to the surface for treatment. This alternative also requires an investigation of hydrogeologic conditions at the plant.

J. COMPARATIVE ANALYSIS OF ALTERNATIVES

The nine criteria used by U.S. EPA to evaluate remedial alternatives, as set forth in the NCP, 40 C.F.R. Part 300.430, include: 1) overall protection of human health and the environment; 2) compliance with applicable or relevant and appropriate requirements (ARARs); 3) long-term effectiveness and permanence; 4) reduction of toxicity, mobility, or volume through treatment; 5) short-term effectiveness; 6) implementability; 7) cost; 8) state acceptance; and, 9) community acceptance.

The first two evaluation criteria are threshold criteria that all alternatives must meet. Criteria 3 through 7 are balancing criteria that are used to compare the alternatives against each other and determine which alternative provides the best balance of the evaluation criteria. The remaining two criteria are modifying criteria. The input from the community and the support agency are considered by the lead agency in making its final decision.

Threshold Criteria

1. **Overall Protection of Human Health and the Environment** addresses whether a remedy provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced or controlled through treatment, engineering, or institutional controls. The selected remedy must meet these criteria.

2. **Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)** addresses whether a remedy will meet applicable or relevant and appropriate federal and state environmental laws and/or justifies a waiver from such requirements. The selected remedy must meet this criteria or a waiver of the ARAR must be attained.

Primary Balancing Criteria

3. **Long-Term Effectiveness and Permanence** refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup levels have been met.

4. **Reduction of Toxicity, Mobility, or Volume Through Treatment** addresses the statutory preference for selecting remedial actions that employ treatment technologies that permanently and significantly reduce toxicity, mobility, or volume of the hazardous substances as their principal element. This preference is satisfied when treatment is used to reduce the principal threats at the site through destruction of toxic contaminants, reduction of the total mass of toxic contaminants, irreversible reduction in contaminant mobility, or reduction of total volume of contaminated media.

5. **Short-Term Effectiveness** addresses the period of time needed to achieve protection and any adverse impacts on human health and the environment that may be posed, until cleanup levels are achieved.

6. **Implementability** is the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement a particular option.

7. **Cost** includes estimated capital costs, annual operation and maintenance costs (assuming a 30-year time period), and net present value of capital and operation and maintenance costs.

<u>**Modifying Criteria**</u>

8. **State Acceptance** considers whether the state agrees with U.S. EPA's analyses and recommendations of the RI/FS and the Proposed Plan, and considers state ARARs.

9. **Community Acceptance** addresses the public's general response to the remedial alternatives and proposed plan. The ROD will include a responsiveness summary that presents public comments and U.S. EPA responses to those comments. Acceptance of the recommended alternative will be evaluated after the public comment period.

Consistent with the rest of this document, the comparative analysis of the nine criteria will be organized by river component and presented in a tabular format.

Upper River Sediment Comparative Analysis								
Nine Criteria	Alt. 1 No Action	Alt. 2 Natural Recovery and Monitoring	Alt. 3-I Removal of 34% of PCBs	Alt. 3-II Removal of 62% of PCBs	Alt. 3-III Removal of 72% of PCBs	Alt. 3-IV Removal of 78% of PCBs	Alt. 3-IV-A Removal of 88% of PCBs	Alt. 3-V Removal of 90% of PCBs
Overall Protection of Human Health and the Environment	No risk reduction.	Allows continued contamination to remain in place. Risk reduction would be achieved through natural processes assuming no continuing sources to the river.	All of these removal alternatives vary to the degree to which they protect against the direct contact threat of contaminated sediments or achieve an average sediment concentration required to meet appropriate human and aquatic receptor levels. Alternative 3-V results in a soft sediment SWAC of 0.4 ppm which equates to a human health risk of 8.1 x 10-5 and falls within the LOAEL to NOAEL range for all aquatic receptors. Alternative 3-IV-A meets the US EPA soft sediment concentration SWAC target of 0.5 ppm which equates to a human health risk of 1.0 x 10-4 and falls within the LOAEL to NOAEL range for all aquatic receptors. Alternatives 3-I through 3-IV do not meet the threshold criteria for protection of human health and the environment and equate to risks greater than 1.0 x 10-4 for the soft sediment deposits. All risks are based on the RME bass consumption scenario.					
Compliance with Applicable or Relevant & Appropriate Requirements (ARARs)	These two alternatives do not involve any further in-river remediation. It is expected that chemical- and location- specific ARARs would be met. Also, since either minimal or no further activity would be taken at the site, it is expected that action-specific ARARs would not be involved. Removal of CTF and SMF sediments is expected to comply with all site ARARs since removed materials would be properly handled and disposed.		It is expected that alternatives I through V could meet all chemical-, location-, and action-specific ARARs for the site over time. However, all of these alternatives hold the possibility for short-term exceedances of Wisconsin surface water quality standards. In addition, since the WDNR has identified the Sheboygan River area as a possible habitat for some endangered species, it is possible that disruption or destruction of their habitat may occur through implementation of any of the six removal alternatives. Such disruptions would be successively greater for each removal alternative. However, reasonable precautionary measures would be undertaken to meet all chemical-, location-, and action-specific ARARs during implementation.					

<table>
<tr><th>Nine Criteria</th><th>Alt. 1
No Action</th><th>Alt. 2
Natural Recovery and Monitoring</th><th>Alt. 3-I
Removal of 34% of PCBs</th><th>Alt. 3-II
Removal of 62% of PCBs</th><th>Alt. 3-III
Removal of 72% of PCBs</th><th>Alt. 3-IV
Removal of 78% of PCBs</th><th>Alt. 3-IV-A
Removal of 88% of PCBs</th><th>Alt. 3-V
Removal of 90% of PCBs</th></tr>
<tr><td>Long-term Effectiveness and Permanence</td><td>Source has not been addressed. Existing risks will remain.</td><td>Relies on natural processes to reduce PCB concentrations.</td><td colspan="6">All of these alternatives vary to the degree to which they address sources and protect human health and the environment over time.

Alternative 3-V meets both the soft sediment SWAC and PCB targets.

Alternative 3-IV-A achieves the soft sediment SWAC target of 0.5 ppm and meets the PCB mass target.

Alternatives 3-I through 3-IV would not remove sufficient contaminated sediment to achieve the soft sediment deposit SWAC target of 0.5 ppm or the PCB mass target of 88%.

Since the Upper River is a dynamic environment, the more PCB mass removed from the system the better the long term effectiveness.</td></tr>
<tr><td>Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment</td><td colspan="8">All alternatives do not permanently and significantly reduce toxicity, mobility, or volume of the hazardous substances through treatment as a principal element. Treatment is not practicable for any alternative.

No alternative is any better than the others because none of the alternatives call for treatment prior to disposal.</td></tr>
<tr><td>Short-term Effectiveness</td><td colspan="2">Alternatives 1 and 2 require no time to implement the remedy and pose no risks to workers, residents and the environment since no excavation is required.</td><td colspan="6">All of these removal alternatives vary to the degree to which they pose risks to workers implementing the remedy. The more PCB mass removed from the system the more time it will to take to conduct the work and that will increase the potential for short term negative impacts to the river. Recreational activities in the Upper River would be disrupted during implementation. Removal of CTF/SMF sediment may include transportation spills however, the likelihood of such an event is of minimal concern.

Alternatives 3-IV-A and 3-V will reach soft sediment protection levels upon completion of the remedy. Alternatives 2, 3-I, 3-II, 3-III, and 3-IV rely on natural processes to reach soft sediment protection levels.

If these alternatives are implemented benthic habitat will be disturbed.</td></tr>
<tr><td>Implementa-bility</td><td colspan="8">No technical or administrative problems preventing implementation are foreseen for Alternatives 2 through 6. Services and materials are available for all alternatives. Implementation will be similar to what occurred during the removal action. Before remediation can take place, a WDNR-approved in-state disposal facility or out-of-state disposal facility must be located.</td></tr>
<tr><td>Cost</td><td>$0</td><td>$4.5 million</td><td>$11.1 million</td><td>$13.8 million</td><td>$15.2 million</td><td>$19.1 million</td><td>$23.8 million</td><td>$25.6 million</td></tr>
<tr><td>State Acceptance</td><td>No</td><td>No</td><td>No</td><td>No</td><td>No</td><td>No</td><td>No</td><td>Yes</td></tr>
</table>

Nine Criteria	Alt. 1 No Action	Alt. 2 Natural Recovery and Monitoring	Alt. 3-I Removal of 34% of PCBs	Alt. 3-II Removal of 62% of PCBs	Alt. 3-III Removal of 72% of PCBs	Alt. 3-IV Removal of 78% of PCBs	Alt. 3-IV-A Removal of 88% of PCBs	Alt. 3-V Removal of 90% of PCBs
Community Acceptance	A complete summary of public comments can be found in the attached Responsiveness Summary.							

Middle River Sediment Comparative Analysis

Nine Criteria	Alternative 1: No Action	Alternative 2: Characterization and Monitored Natural Processes	Alternative 3: Characterization, Sediment Removal and Monitored Natural Processes
Overall Protection of Human Health and the Environment	No risk reduction.	Current SWAC is 1.5 ppm based on RI data. Would meet the U.S. EPA soft sediment concentration SWAC target of 0.5 ppm which equates to a human health risk of 1.0 x 10-4 and falls within the LOAEL to NOAEL range for all aquatic receptors over time. Long-term monitoring will track sediment and fish concentrations over time.	Meets the U.S. EPA soft sediment concentration SWAC target of 0.5 ppm which equates to a human health risk of 1.0 x 10-4 and falls within the LOAEL to NOAEL range for all aquatic receptors upon completion of remedial action. Long-term monitoring will track sediment and fish concentrations over time.
Compliance with Applicable or Relevant & Appropriate Requirements (ARARs)	N/A	This alternative does not involve any further in-river remediation. It is expected that chemical- and location-specific ARARs would be met. Also, since further activity would be taken at the site, it is expected that action-specific ARARs would not be involved.	It is expected that this alternative could meet all chemical-, location-, and action-specific ARARs for the site over time. However, all of these alternatives hold the possibility for short-term exceedances of Wisconsin surface water quality standards. In addition, since the WDNR has identified the Sheboygan River area as a possible habitat for some endangered species, it is possible that disruption or destruction of their habitat may occur through implementation of this alternative. However, reasonable precautionary measures would be undertaken to meet all chemical-, location-, and action-specific ARARs during implementation.
Long-term Effectiveness and Permanence	Existing risks will remain.	Under this alternative, existing source has not been addressed. Relies on natural processes to reduce PCB concentrations to 0.5 ppm, or less, for soft sediment deposits. This will benefit the benthic community in the long run as a less contaminated and healthier substrate will be established for benthic populations.	PCB-contaminated soft sediment deposits would be removed to establish a soft sediment SWAC of 0.5 ppm . Over time natural processes would further reduce PCB concentrations. This will benefit the benthic community in the long run as a less contaminated and healthier substrate will be established for benthic populations.
Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment	No alternative reduces toxicity, mobility, or volume of the hazardous substances through treatment as a principal element.		
Short-term Effectiveness	Requires no time to implement and poses no risks to workers, residents and the environment since no excavation is required.	Requires no time to implement and poses no risks to workers, residents and the environment since no excavation is required. If the current Middle River SWAC is still near 1.5 ppm natural processes will be necessary to achieve soft sediment SWAC of 0.5 ppm over a longer term than currently anticipated. If current SWAC is significantly lower than 1.5 ppm, 0.5 ppm can be achieved in a shorter period of time.	Short term mobility of PCBs may increase as a result of sediment resuspension during dredging operations. Although some short-term effects inherent to dredging could be mitigated through daily monitoring, use of silt curtains, and implementation of the site-specific health and safety plan. Recreational activities in the Middle River would be disrupted during implementation. Middle River soft sediment SWAC of 0.5 ppm will be achieved upon completion of alternative. There will be short-term adverse impacts to the benthic habitat and community.

Nine Criteria	Alternative 1: No Action	Alternative 2: Characterization and Monitored Natural Processes	Alternative 3: Characterization, Sediment Removal and Monitored Natural Processes
Implementability	No technical or administrative problems preventing implementation are foreseen for Alternatives 1 and 2. Services and materials are available for all alternatives. Before removal can take place, a WDNR-approved disposal facility must be located.		
Cost	$0 million	$2.0 million	$12.0 million
State Acceptance	No	No	No
Community Acceptance	A complete summary of public comments can be found in the attached Responsiveness Summary.		

Lower River & Inner Harbor River Sediment Comparative Analysis							
Nine Criteria	Alt. 1: No Action	Alt 2: Natural Recovery and Monitoring	Alt. 3: Sediment Trap	Alt. 4: Removal of Sediment Disturbed by Natural and Recreational Impacts	Alt. 5: Sediment Capping	Alt. 6: Removal of Surface Sediment	Alt. 7: Complete Excavation
Overall Protection of Human Health and the Environment	No risk reduction.	If the current Lower River SWAC is 5.5 ppm, then this alternative relies natural processes and the on the introduction of cleaner upstream sediments to achieve a Lower River SWAC of 0.5 ppm over time. If NOAA samples taken in 1997 are more representative of the Lower River SWAC the 0.5 ppm may be achieved in a short period of time for the Lower River. Sediment and fish monitoring would track PCB levels over time.	This alternative would achieve a Lower River and Inner Harbor SWAC of 0.5 ppm over time through the introduction of cleaner upstream sediments. The sediment trap would add a risk management component to the overall river remedy and "trap" relatively small amounts of contaminated sediment in the Inner Harbor before migrating into Lake Michigan. Sediment and fish monitoring would track PCB levels over time.	This alternative is expected to achieve an Inner Harbor SWAC of 0.5 ppm upon completion of, or shortly after, remedial activities. This alternative will remove contaminated sediment in areas of the Inner Harbor that are vulnerable to recreational boating or scour. Sediment and fish monitoring would continue to track PCB levels over time. This alternative would achieve a Lower River SWAC of 0.5 ppm shortly after implementation, if NOAA's samples, taken in 1997, are more accurate	This alternative would achieve a Lower River and Inner Harbor SWAC of 0.5 ppm over time through the introduction of cleaner upstream sediments. This alternative would introduce a "protective layer" between the surface and the more highly contaminated sediments. Adding 32 inches of cap material over the Inner Harbor could significantly affect use of the boat moorings under low Lake Michigan water conditions. Sediment and fish monitoring would track PCB levels over time.	This alternative would achieve an Inner Harbor SWAC of 0.5 ppm, or less, upon completion of remedial activities. This alternative would not remove additional contaminated sediment vulnerable to scour which could mean an increase in surface sediments in areas vulnerable to scour. Sediment and fish monitoring would continue to track PCB levels over time.	This alternative would achieve an Inner Harbor SWAC of 0.5 ppm, or less, upon completion of remedial activities. Sediment and fish monitoring would continue to track PCB levels over time.

Nine Criteria	Alt. 1: No Action	Alt 2: Natural Recovery and Monitoring	Alt. 3: Sediment Trap	Alt. 4: Removal of Sediment Disturbed by Natural and Recreational Impacts	Alt. 5: Sediment Capping	Alt. 6: Removal of Surface Sediment	Alt. 7: Complete Excavation
Compliance with Applicable or Relevant & Appropriate Requirements (ARARs)	These two alternatives do not involve any further in-river remediation. It is expected that chemical- and location-specific ARARs would be met. Also, since either minimal or no further activity would be taken at the site, it is expected that action-specific ARARs would not be involved.		These dredging alternatives could possibly involve short-term exceedances of the Wisconsin water quality standards. As with any treatment process, a temporary exceedance of permitted effluent levels may sometimes occur, although the facility would be properly maintained and operated. However, precautionary measures would be undertaken to comply with all ARARs.		This alternative would comply with all chemical-, location, and action- specific ARARs.	These dredging alternatives could possibly involve short-term exceedances of the Wisconsin water quality standards. As with any treatment process, a temporary exceedance of permitted effluent levels may sometimes occur, although the facility would be properly maintained and operated. However, precautionary measures would be undertaken to comply with all ARARs.	
Long-term Effectiveness and Permanence	Under this alternative, contaminated sediment is not addressed and it relies on natural processes to reduce PCB concentrations in surface sediments over time. Exposure to contaminated sediment due to recreational boating or scour would remain.	Like the no-action alternative, contaminated sediment is not addressed and it relies on natural processes to reduce PCB concentrations in surface sediments over time. Exposure to contaminated sediment due to recreational boating or scour would remain. Long term monitoring will track sediment and fish tissue concentrations.	Although some contaminated sediment will be removed to create the trap, like Alternatives 1 and 2, most of the surficial contaminated sediment is not removed. This alternative relies on natural processes to reduce PCB concentrations in surface sediments over time. Exposure to contaminated sediment due to recreational boating or scour will remain.	This alternative removes contaminated surficial sediment over approximately 45% of the Inner Harbor. It also removes contaminated sediment in areas of the Lower River and Inner Harbor that are vulnerable to recreational boat disturbances and scour during high flow events. Excavated areas will be backfilled with clean sediment.	While this alternative does not remove contaminated sediment, it would create a barrier between what is currently in place and upstream sediment deposited in the future. Properly designed, the cap would be expected to be effective. Implementation of the cap may interfere with the current recreational use of the harbor by some water craft.	This alternative removes the top 2 feet of sediment in the Inner Harbor, but would not remove sediment in areas subject to scour during high flow events causing the possible release of those sediments. Excavated areas would be backfilled with clean sediment. Exposure to contaminated sediment scour would remain. This alternative would rely on natural processes to reduce PCB concentrations in the Lower River.	This alternative removes all existing contaminated sediment from the Inner Harbor and would rely on natural processes to reduce PCB concentrations in the Lower River.

Nine Criteria	Alt. 1: No Action	Alt 2: Natural Recovery and Monitoring	Alt. 3: Sediment Trap	Alt. 4: Removal of Sediment Disturbed by Natural and Recreational Impacts	Alt. 5: Sediment Capping	Alt. 6: Removal of Surface Sediment	Alt. 7: Complete Excavation
Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment	Does not permanently or significantly reduce toxicity, mobility, or volume of the hazardous substances as a principal element.	None of the alternatives reduce toxicity, mobility or volume through treatment as excavated sediments are not planned to be treated prior to disposal.					
Short-term Effectiveness	These alternatives require no time to implement and pose no risk to workers, residents and the environment since no excavation is required. These alternatives may require natural processes to reach 0.5 ppm soft sediment SWAC and will take longer than to reach that sediment target than other more comprehensive alternatives.		All of these alternatives increase in short-term impacts as volume of contaminated sediment removed is increased. The likelihood of adverse impacts to the benthic community and potential releases of PCBs into the water column are similar for all of these alternatives. Removal of contaminated sediment or implementation of a sediment cap will disrupt recreational use of the Inner Harbor. Short-term effects could be minimized through daily monitoring, use of silt curtains, and implementation of a site-specific health and safety plan. Alternative 3 would require natural processes to reach 0.5 ppm soft sediment SWAC. Alternatives 4, 5, 6 and 7 would meet soft sediment SWAC target shortly after implementation.				
Implementability	Before removal can take place, a WDNR-approved disposal facility must be located. Before a sediment cap can be placed on contaminated sediment in the Inner Harbor this would have to be approved by the USACE as the Inner Harbor contains a Congressionally authorized navigation channel. Deauthorization of the navigational channel would be necessary before a cap can be installed.						
Cost	$0	$3.1 Million	$9.3 Million	$10.0 Million	$10.8 Million	$14.6 Million	$169.3 Million
State Acceptance	No	No	No	No	No	No	Yes
Community Acceptance	A complete summary of public comments can be found in the attached Responsiveness Summary.						

Floodplain Soil Comparative Analysis

Nine Criteria	Alt. 1: No Action	Alt 2: Bank Soil Stabilization	Alt. 3: Removal of Soil Containing More than 50 ppm of PCBs	Alt. 4: Removal of Soil Containing More than 10 ppm of PCBs
Overall Protection of Human Health and the Environment	No risk reduction.	This alternative is not protective of the ecological receptors based on the U.S. EPA terrestrial risk assessment.	This alternative is not protective of ecological receptors based on the U.S. EPA terrestrial risk assessment.	This alternative is protective of ecological receptors based on the U.S. EPA terrestrial risk assessment.
		All three floodplain alternatives are protective of human health risks based on the 1993 U.S. EPA risk assessment.		
Compliance with Applicable or Relevant & Appropriate Requirements (ARARs)	Since this alternative does not involve any active remediation, no action-specific ARARs would be triggered. It is expected that location-specific ARARs would also be met. This alternative may not comply with the chemical-specific Wisconsin Soil Cleanup Standards.	This alternative may not comply with the chemical-specific Wisconsin Soil Cleanup Standards. This alternative would comply with chemical-specific ARARs for the site. This alternative would likely comply with action- and location-specific ARARs as well, through appropriate management of removed materials. However, it is possible that disruption or destruction of any identified endangered species and/or habitat could occur. However, precautionary measures would be undertaken to comply with action- and location-specific ARARs during implementation of this alternative.	These alternatives would comply with chemical-specific ARARs for the site. These alternatives would likely comply with action- and location-specific ARARs as well, through appropriate management of removed materials. However, it is possible that disruption of any identified endangered species and/or habitat could occur. However, precautionary measures would be undertaken to comply with action- and location-specific ARARs during implementation of these alternatives.	
Long-term Effectiveness and Permanence	Under this alternative, the source has not been addressed. Relies on natural processes to reduce PCB concentrations. Existing risks will remain.	Like the no-action alternative, source material is not addressed, allowing potential migration of PCB-contaminated soil from the floodplain areas to the river during high flow events. Bank stabilization would decrease soil erosion measures and provide additional protection to human health and the environment.	The effects of these two alternatives involving excavation are expected to be prompt and permanent as PCB-contaminated soils are removed from the floodplain areas. Alternative 4 removes more material than Alternative 3 and will reduce PCB SWAC concentrations to levels necessary to meet the risk targets of ecological receptors.	

Nine Criteria	Alt. 1: No Action	Alt 2: Bank Soil Stabilization	Alt. 3: Removal of Soil Containing More than 50 ppm of PCBs	Alt. 4: Removal of Soil Containing More than 10 ppm of PCBs
Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment	Does not permanently or significantly reduce toxicity, mobility, or volume of the hazardous substances as a principal element.	This alternative would remove approximately 670 cubic yards of PCB-contaminated soil.	This alternative would remove approximately 2,600 cubic yards of PCB-contaminated soil.	This alternative would remove approximately 10,800 cubic yards of PCB-contaminated soil.
		With each successive alternative more volume of PCB-contaminated soil is removed. The placement of appropriate soil erosion control measures would reduce the potential mobility of PCBs in the floodplain areas. Alternatives 3 and 4 remove significantly more PCB-contaminated soil. Under each alternative, excavated soil would be disposed of in a WDNR-approved facility and is not planned to be treated prior to disposal.		
Short-term Effectiveness	Requires no time to implement and poses no risks to workers, residents and the environment since no excavation is required.	The short-term effects of excavation on the floodplain areas would likely include disruption/destruction of natural areas near the river to construct access roads and staging areas and potential spillage of soils into the river during removal or conveyance of soil across the river. Alternative 2 would not entail the disruption /destruction of as much natural area. Implementation of Alternatives 3 and 4 will be balanced with keeping as much high-quality habitat in place as possible. Reasonable and appropriate environmental control measures (i.e. silt curtains, hay bales) and a site-specific health and safety plan would be implemented as part of each removal alternative.		
Implementability	All floodplain soil alternatives involving excavation would not present issues with regard to implementability. Negotiations with affected landowner(s) would be necessary for gaining access.			
Cost	$0 million	$0.6 million	$1.8 million	$4.5 million
State Acceptance	No	No	No	Yes
Community Acceptance	A complete summary of public comments can be found in the attached Responsiveness Summary.			

Ground-water and Additional PCB Sources Comparative Analysis

Nine Criteria	Alt. 1: No Action	Alt 2: Investigation / Source Identification and Control	Alt. 3: Collection Trench and Treatment	Alt. 4: Facility Perimeter Cut-off Wall
Overall Protection of Human Health and the Environment	No risk reduction.	Alternatives 2 through 4 may provide a similar level of protection from potential adverse effects of PCBs from contaminated ground-water, however, it is unclear whether complete exposure pathways between facility ground-water and the river currently exist. River bank samples taken in 1999 indicate an additional source from Tecumseh's Sheboygan Falls plant. Alternative 2 would allow for further investigations to determine what remedial measures are necessary to control or eliminate further introduction of PCB to the Sheboygan River. Alternatives 3 or 4 will be necessary if additional sourcing to the river is due to contaminated ground-water and natural attenuation is not an appropriate remedial alternative.		
Compliance with Applicable or Relevant & Appropriate Requirements (ARARs)	This alternative would not trigger action- or location-specific ARARs, since no active remediation would be conducted. PCB concentrations in Tecumseh's Sheboygan Falls plant ground-water exceed WDNR ES and thus are not assumed to be compliant with the chemical-specific ARAR. Natural process may reduce PCB concentrations over time.	Further sampling under this alternative may indicate that Tecumseh's Sheboygan Falls plant ground-water is compliant with all chemical-specific ARARs. If PCB concentrations found in Tecumseh's Sheboygan Falls plant ground-water still exceed the WDNR enforcement standard, then source identification and control and natural processes would be expected to reduce PCB concentrations over time.	Removed materials would likely comply with chemical-specific ARARs, as these materials would be handled and subsequently disposed in an appropriate landfill. Short-term exceedances of the Wisconsin surface water quality standards may occur upon discharge of treated water back to the River as part of alternatives 3 and 4. Water would be treated through the existing CWTF, which consists of a BAT process. As with any treatment process, a temporary exceedance of permitted effluent levels may sometimes occur, although the facility (CWTF) would be properly maintained and operated. Removal activities would likely comply with action- and location-specific ARARs through appropriate management of removed materials. Precautionary measures directed toward compliance with action- and location-specific ARARs during implementation of these alternatives would be undertaken.	

Nine Criteria	Alt. 1: No Action	Alt 2: Investigation / Source Identification and Control	Alt. 3: Collection Trench and Treatment	Alt. 4: Facility Perimeter Cut-off Wall
Long-term Effectiveness and Permanence	Under this alternative, additional sources have not been addressed. If ground-water is contaminating the river, no action relies on natural processes to reduce PCB concentrations over time.	The Collection Trench and Treatment and Facility Perimeter Cut-off Wall alternatives would be maintained in operation until the calculated loading of Tecumseh's Sheboygan Falls plant ground-water discharges to the river is within acceptable limits. Source control measures implemented as part of the Investigation and Control alternative and the hydraulic control implemented as part of the Collection Trench and Treatment and Facility Perimeter Cut-off Wall alternatives would provide these alternatives with further effectiveness and permanence. However, the extent of any further effectiveness is unknown pending further investigations. The existing City of Sheboygan Falls ordinance provides some adequacy and reliability in terms of long-term control to limit potential future exposure to ground-water. Further limitations for exposure to ground-water could be achieved through deed restrictions. Ground-water monitoring would provide a means to track PCB concentrations in ground-water over time.		
Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment	Does not permanently or significantly reduce toxicity, mobility, or volume of the hazardous substances as a principal element.	Source control measures would further reduce the mobility and volume of PCBs that may be entering the river from the ground-water system. Ground-water collection and treatment, conducted as part of the Collection Trench and Treatment or Facility Perimeter Cut-off Wall alternatives may reduce the mass of PCBs in ground-water based on further investigations. However, due to the low PCB mobility, ground-water removal and treatment may not significantly reduce PCB mass in ground-water. Alternatives 3 and 4, however, would significantly reduce the volume of PCBs entering the Sheboygan River from the Tecumseh's Sheboygan Falls plant area.		
Short-term Effectiveness	Requires no time to implement and poses no risks to workers, residents and the environment since no excavation is required.	In general, Alternatives 2 through 4 should not increase risk to the community beyond the existing conditions. Risks associated with the installation of the Collection Trench or Facility Perimeter Cut-off Wall would be confined to the workers during the completion of additional monitoring and construction activities, and during treatment of water throughout an assumed 30-year period. A site-specific health and safety plan would minimize potential exposure risks.		
Implementability	No Issues	The technical ability to monitor and install wells has been demonstrated at Tecumseh's Sheboygan Falls plant in the past. Essentially similar conditions are anticipated during implementation of excavation activities. The technical implementability of additional source control measures would depend on the results of the additional investigations and necessary control measures. The technical implementability of constructing a collection trench or a cut-off wall is not expected to be an issue. However, implementation of the cut-off wall may be challenging in close proximity to Tecumseh's Sheboygan Falls plant. Equipment and services are expected to be available in sufficient supply to implement any of these alternatives.		
Cost	$0 million	$0.6 million	$1.5 million	$3.6 million
State Acceptance	No	Yes	Yes	Yes

Nine Criteria	Alt. 1: No Action	Alt 2: Investigation / Source Identification and Control	Alt. 3: Collection Trench and Treatment	Alt. 4: Facility Perimeter Cut-off Wall
Community Acceptance	A complete summary of public comments can be found in the attached Responsiveness Summary.			

K. PRINCIPAL THREAT WASTES

The NCP establishes an expectation that U.S. EPA will use treatment to address the principal threats posed by a site wherever practicable (NCP Section 300.430(a)(1)(iii)(A)). The "principal threat" concept is applied to the characterization of "source materials" at a Superfund site. A source material is material that includes or contains hazardous substances, pollutants or contaminants that act as a reservoir for migration of contamination to ground water, surface water, or air, or acts as a source for direct exposure. Principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained, or would present a significant risk to human health or the environment should exposure occur.

Although no "threshold level" of risk has been established to identify principal threat waste, a general rule of thumb is to consider as a principal threat those source materials with toxicity and mobility characteristics that combine to pose a potential risk several orders of magnitude greater than the risk level that is acceptable for the current or future site use.

Based on human health risks at the Sheboygan River and Harbor site, the threshold risk level of 1×10^{-4} equates to a sediment PCB contaminant level of approximately 0.5 ppm. Accordingly, contaminated sediment with levels exceeding 50 ppm may be determined to be a principal threat waste. However, the highest LOAEL for the most sensitive ecological receptor analyzed by NOAA was approximately 1.0 ppm. Based on ecological risks, contaminated sediment with levels exceeding 100 ppm may be considered a principal threat waste for ecological receptors. Therefore, the lower of the two thresholds, 50 ppm, is considered principal threat waste in areas subject to mobility due to human and natural disturbances. The dynamic nature of the Upper and Middle River portions of the site make soft sediment deposits in both of these river reaches vulnerable to natural disturbances. Low water levels in the Lower River and Inner Harbor make some areas within these river reaches vulnerable to recreational and natural disturbances.

L. SELECTED REMEDY

This section of the ROD will be organized into three sections: 1) Description and Rationale for the Selected Remedy, 2) Summary of the Estimated Remedy Costs, and 3) Expected Outcomes of Selected Remedy

Summary and Description of the Rationale for the Selected Remedy

The summary of the rationale for the selected remedy will be addressed for each site component.

Upper River Sediments

The remedy for this river component is to re-characterize the Upper River and remove a minimum of 88 percent of the remaining PCB mass in the soft sediment deposits to remove mobile mass and achieve a soft sediment SWAC in the Upper River of less than or equal to 0.5 ppm. U.S. EPA estimates that approximately 20,774 cubic yards will be removed from the Upper River soft sediment deposits to achieve this goal. U.S. EPA expects that removal of this amount of remaining PCB mass will result in an overall PCB sediment SWAC of 0.5 ppm in the Upper River over time. Because some PCB mass will remain in place, a 30 year monitoring program will be implemented to monitor sediment and fish tissue concentrations to ensure that over time the entire river will reach an average PCB sediment concentration of 0.5 ppm or less, and that over time fish consumption advisories will be phased out.

The U.S. EPA selects a remedy for this river component which emphasizes the removal of soft sediment deposits as these areas act as a PCB source for the rest of the river. PCB contamination is found in both the soft sediment deposits and scattered soft sediment in the non-soft sediment areas of the river, or described hereafter as the hard sediments. The approximate surface area represented by the soft sediment deposits is 15 percent, with the hard sediment area representing the remaining 85 percent in the Upper River. See Appendix D of the 1998 FS for a detailed explanation of this approach. PCB contamination levels vary throughout the entire river. Based on sampling conducted by the WDNR in 1997, surficial PCB contamination, in the hard sediment area ranged from 0.3 ppm to 5.3 ppm, averaging 2.5 ppm for the 10 samples taken over the 3.8 mile stretch of the Upper River.

To determine an overall river SWAC, PCB contamination in the soft sediment deposits and hard sediments are prorated to account for their overall effect on the aquatic receptors. The FS used the two dimensional surface area of the soft sediment deposits and hard sediment area which equalled 15 percent for the soft sediment deposits and 85 percent for the hard sediments. The FS recommended alternative 3-II. This alternative includes the removal of approximately 7,500 cubic yards of PCB-contaminated soft sediment which reduces the soft sediment deposit SWAC to 2.8 ppm. Implementing this alternative will result in an overall Upper River SWAC of 2.55 ppm upon completion of remedial activities in the Upper River.

Overall Upper River SWAC = (Ave. Soft Sediment Deposit Concentration x 15%) +
(Ave. Hard Sediment Concentration x 85%)

Overall Upper River SWAC = (2.8 ppm x 0.15) + (2.5 ppm x 0.85) = 2.55 ppm

Removing approximately 20,774 cubic yards results in a soft sediment deposit SWAC of 0.5 ppm. A soft sediment deposit SWAC of 0.5 ppm results in an overall Upper River SWAC of 2.20 ppm.

Overall Upper River SWAC = (0.5 ppm x 0.15) + (2.5 ppm x 0.85) = 2.20 ppm

These two soft sediment deposit targets don't yield a significant difference in the overall river SWAC if a15 percent / 85 percent SWAC ratio is assumed. However, a 15 percent factor likely under represents the risk impact of PCBs in these soft sediment deposits. There are a number of reasons for this.

- The proposed 15 percent / 85 percent weighting approach assumes a static model and is inappropriate for a dynamic river system. The soft sediment PCBs are more likely to be mobilized and transported in comparison with hard sediment PCBs. This difference in mobility is not accounted for by the 15 percent / 85 percent surface area weighting. During sediment investigations, conducted as part of the NOAA Aquatic Risk Assessment in July and August of 1997, NOAA and WDNR staff observed that soft sediment deposits had significantly shifted or had been significantly disturbed in portions of the Upper River demonstrating the mobility of these soft sediment deposits.

- The proposed 15 percent / 85 percent weighting approach does not address source control, that is, PCB-contaminated soft sediment deposits are the most likely source of fine grained silts and clays in the hard sediment area.

  An analogy would be a large pile of contaminated dirt from which a plume of dirt has been blown off downwind. The plume of blown-off dirt would appear to be the major repository of contaminants based solely on an aerial comparison of the two-dimensional surface area of the pile versus the area of the plume. Emphasizing remedial efforts on the plume as a result of this two dimensional comparison would be a mistake. In contrast, consideration of mass and potential mobility would correctly focus the cleanup efforts on the pile, and secondarily on the dispersed plume.

- The proposed 15 percent / 85 percent weighting approach does not take into account the actual spatial dispersion of soft sediment in the hard sediment area. PCBs are unlikely to occur in truly hard bottoms. They are more likely presented in scattered inclusions of fine sediments in the hard sediment areas. If so, it is inappropriate to compare the total area of hard sediments with the surface area of soft sediment deposits. It is more likely that the average PCB concentration for the hard sediment area is lower than the 2.5 ppm estimated if the soft sediment within the hard sediment area was accurately estimated. This would then mean that overall Upper River SWAC of 2.20 currently overestimated. However, even this adjustment for the spatial dispersion of soft sediments in the hard sediment area would not address the source concern discussed previously.

- The proposed 15 percent / 85 percent weighting approach does not accurately account for the ecological risks for many of the fish species that reside in the

Sheboygan River. Information submitted by Blasland, Bouck & Lee, Inc. (BBL), administrative record update #3, Item # 41, indicates that smallmouth bass prefer the hard sediment areas which BBL contends supports the Feasibility Study (FS) 15 percent / 85 percent SWAC weighting. However, state-wide surveys of fish species reported to forage in the Sheboygan River show that even smallmouth bass often frequent sand/silt/mud areas greater than the 15 percent assigned to the soft sediment deposits. Exhibit 2 shows the frequency of soft bottom types associated with various fish species in the Sheboygan River.

- The proposed 15 percent / 85 percent weighting approach underestimates risks to other wildlife. This is especially true for piscivorus wildlife such as the mink and blue heron. The food chains for both species are linked to soft sediments. It is the PCBs associated with soft sediments, not a weighted average concentration, which are available to these species. The blue heron is an opportunistic feeder that utilizes sight to locate prey. It does this by wading or standing and waiting for prey. Such feeding behavior requires still or slow moving water so that prey may be observed and captured. This type of feeding strategy cannot be efficiently implemented in the riffle areas, which are associated with hard sediments. Unlike the blue heron, mink are capable of consuming large prey such as carp, which will also be more closely associated with soft sediments.

Table 14 - Summary of SWAC Analysis

	Overall River SWAC Based on Post-Remediation Soft Sediment SWAC of	
Soft Sediment vs. Non-Soft Sediment Weighting	2.8 ppm	0.5 ppm
15% / 85%	2.55	2.20
25% / 75%	2.58	2.00
50% / 50%	2.65	1.50
75% / 25%	2.73	1.00
85% / 15%	2.76	0.80

Based on all of this information, soft sediment deposits likely play a much larger role in risks to the river system than the 15 percent attributed to them in the FS and will vary depending on the receptor analyzed. Table 14 demonstrates that the greater the weighting of the soft sediment deposits in the overall river SWAC calculation, the more significant removal of the soft sediment deposits becomes. The qualitative information presented earlier indicates that the soft sediment deposits likely have a greater impact than the 15 percent that the FS assigns.

In summary, the remedy for the Upper River removes a minimum of 88 percent of the remaining mass in the soft sediment deposits to achieve a soft sediment deposit SWAC in the Upper River of 0.5 ppm or less. Removing 88 percent of the remaining PCB mass is likely to result in an overall Upper River SWAC of 0.5 ppm, or less, shortly after remediation because the average PCB concentration of 2.5 ppm for the hard sediments is likely overstated as it doesn't account for the actual spatial distribution of soft sediment in the hard sediment area.

In developing sediment removal alternatives, the PRP used 1997 data and calculated the PCB mass for each of the soft sediment deposits in the Upper River. The soft sediment deposits were sorted from the largest to smallest PCB mass. Next, the deposits were evaluated based on access area "groupings" (i.e., grouping areas with higher masses that may be accessed from the same access areas). The areas were plotted as mass removed (and percent mass reduction) per sediment volume removed, where steeper/similarly sloped areas (i.e., largest reduction in PCB mass per cubic yard of sediment removed) were combined at the beginning of the curve. This approach to sediment removal is shown graphically in Figure 5. Exhibit 3 of this ROD shows the specific soft sediment deposits assigned to each FS Upper River removal alternative.

The U.S. EPA evaluated twelve additional soft sediment removal approaches to determine if similar SWAC and PCB mass targets could be achieved for less cost. An evaluation describing these approaches is in Administrative Record Update #5. The additional approaches included focusing on soft sediment SWAC reduction, PCB mass reduction, and combinations of SWAC and mass reduction. In evaluating these different approaches, focusing the order of soft sediment deposits to reach a PCB concentration of 1.0 ppm and then reordering the remaining deposits to focus on PCB mass removal yielded similar results at a slightly lesser cost. This approach is shown graphically in Figure 6, while the specific soft sediment deposit order is in Exhibit 4.

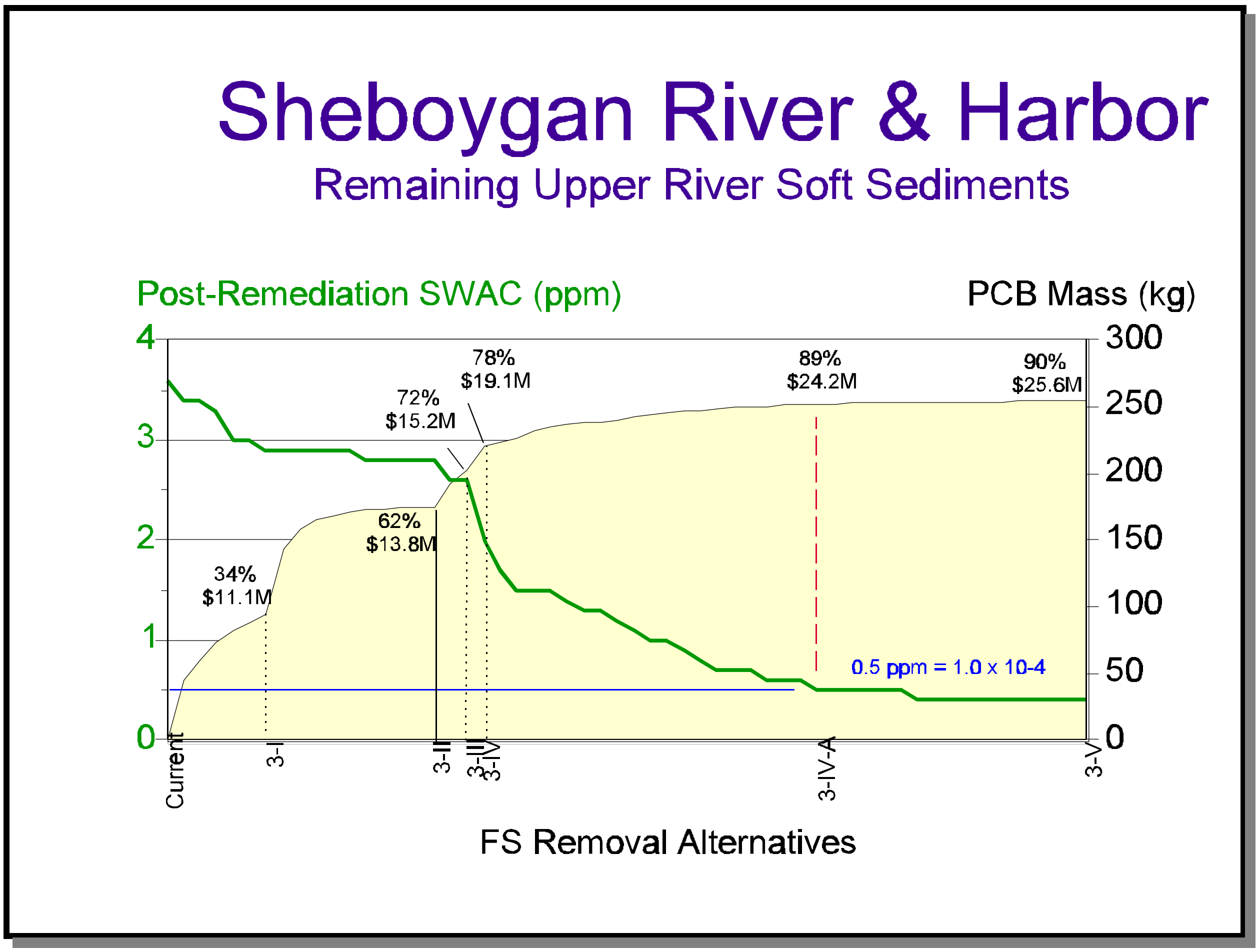


Figure 5

This removal approach has an estimated cost of $23,800,000 and gives the most economical cost per PCB mass of the thirteen approaches analyzed. This approach is approximately $300,000 less than the FS approach and the reduction in cost is due to the removal of less sediment.

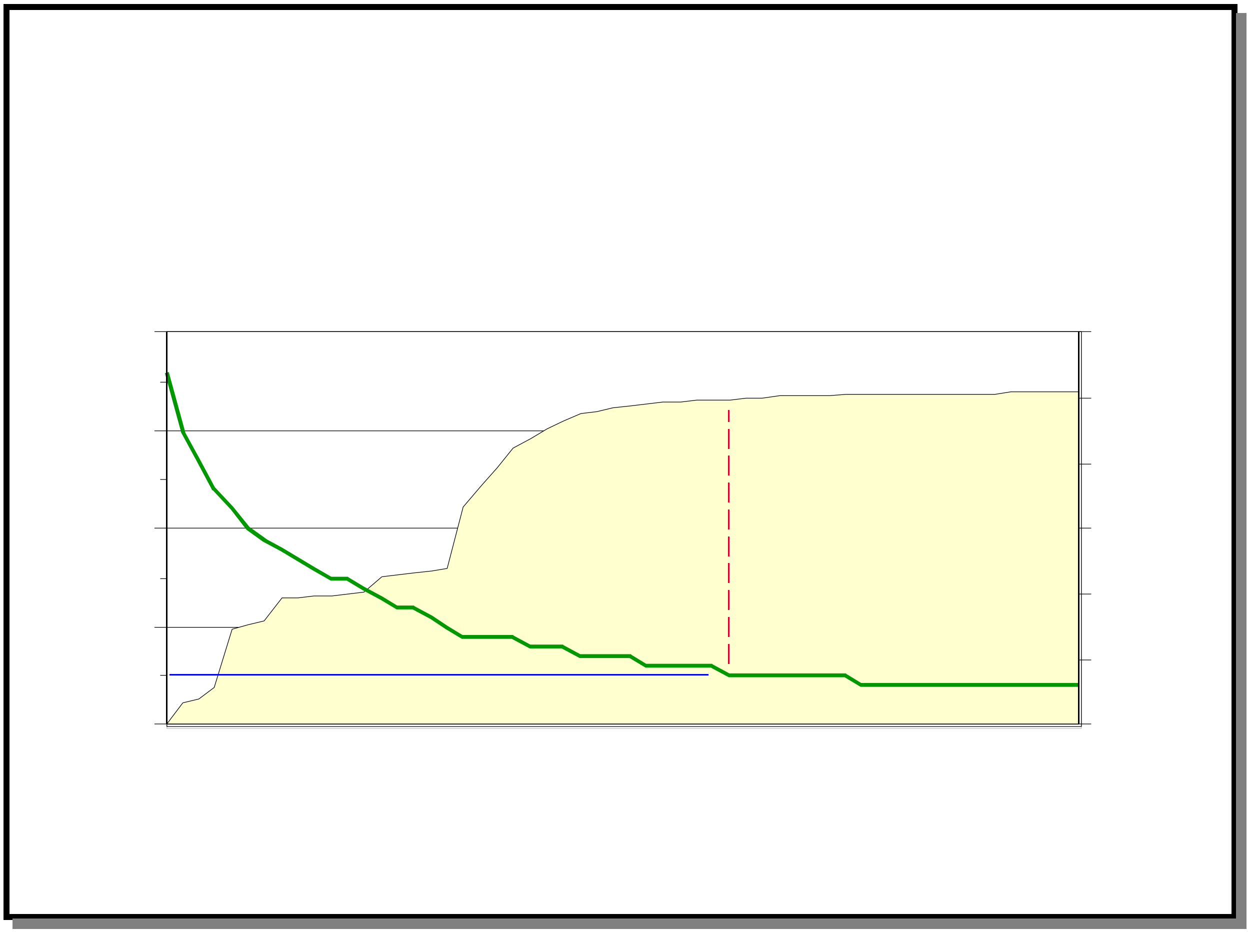


Figure 6

The selected remedy for the Upper River is Alternative 3-IV-A, based on the SWAC and mass reduction approach presented in Figure 6. This approach removes an estimated 20,744 cubic yards of PCB-contaminated sediment containing 88 percent of the Upper River's remaining PCBs. Removal of 88 percent of the remaining PCBs in the Upper River will be required to achieve a PCB soft sediment deposit SWAC 0.5 ppm for the Upper River. Under this alternative, the areas capped/armored during ASRI/removal action activities will be removed, including Area 1. Sediment removal under this alternative requires five access points along the Upper River. Annual fish sampling will occur until fish consumption advisories are lifted. Sediment samples will be taken at least once every five years, after dredging is complete, to document natural processes and to ensure that over time the entire river will reach an average PCB sediment concentration of 0.5 ppm, or less, and that over time fish consumption advisories will be phased out.

Upper River Selected Remedy: Alternative 3-IV-A

Estimated Capital Cost: $30.6 million
Annual O & M Cost: $140,000 or $175,000
Duration of O & M: 30 years
Total Present Value (7% discount rate): $23.8 million.
Estimated Time to Implement: 60 months

Middle River Sediments

The makeup of the Middle River is similar to the Upper River with distinct soft sediment and hard sediment areas. Soft sediment, in the Middle River, is generally deposited intermittently in a relatively thin or shallow layer along the river banks. The remedial objective of the Middle River is similar to the Upper River and is to achieve a Middle River soft sediment SWAC of 0.5 ppm. While the Middle River contains PCB source material, the PCB concentrations are generally less than the Upper River. While there is more soft sediment, approximately 35,000 cubic yards in the Middle River, versus 22,500 cubic yards in the Upper River, the 35,000 cubic yards is stretched over 7 miles, versus 22,500 cubic yards over 4 miles in the Upper River.

As described under, Section E. Site Characterization, PCB concentrations have historically ranged from non-detect to 37 ppm in the Middle River. Exhibit 5, attached to the ROD, shows the Middle River SWAC calculations based on information obtained during site investigations. The PCB concentration for each deposit is from the May 1990 Remedial Investigation/Enhanced Screening (RI/ES) Report and soft sediment deposit volume figures come from Table B-2 of the FS. Using this information, the estimated 35,000 cubic yards of soft sediment contains roughly 60 kg of PCBs and has a soft sediment SWAC of 1.5 ppm. To achieve a PCB soft sediment SWAC of 0.5 ppm, an estimated 12,500 cubic yards of sediment, equaling 31 kg, must be removed. The soft sediment deposits targeted for removal are scattered along the entire 7 smile stretch and would likely require 4 access points to remove these soft sediments. Using the cost assumptions outlined in the FS, characterization of the Middle River and removal of soft sediment to achieve a soft sediment SWAC of 0.5 ppm costs $12.0 million dollars. This includes 30 years of sediment and biota monitoring (Middle River Alternative 3). Characterization and long-term sediment and biota monitoring for the Middle River costs $1.9 million dollars (Middle River Alternative 2).

Thirty-one kilograms of PCBs make up the difference between an estimated SWAC of 1.5 ppm and 0.5 ppm. In evaluating the five balancing criteria, the relatively small amount of PCBs over seven miles do not represent a significant concern with regards to the long-term effectiveness of reaching 0.5 ppm for this river component or other river components downstream. In addition, as indicated by more recent data for other parts of the river, it is likely that current soft sediment SWAC is lower than 1.5 ppm estimated using the FS data. Since the targeted soft sediment deposits are scattered along the entire Middle River, four access points are necessary, raising implementability concerns. Considering all of these issues and because contamination will be left in place, the U.S. EPA selects Alternative 2: Characterization and Monitored Natural Processes for the Middle River.

Middle River Selected Remedy: Alternative 2

Estimated Capital Cost: $0
Annual O & M Cost: $140,000 or 147,000
Duration of O & M: 30 years
Total Present Value (7% discount rate): $2.0 million.
Estimated Time to Implement: 0 years

Due to the presence of PCB contamination and the dynamic nature of the river, this component of the river will be characterized to establish a baseline for evaluating natural process trends and tracking soft sediment concentrations toward a soft sediment SWAC of 0.5 ppm for the Middle River over time. Within the last few years, high flow events may have significantly disturbed and redistributed soft sediment in the Middle River. In addition, contaminated sediment from the Upper River portion of the site may have migrated to the Middle River and with the identification of possible continuing sources near Tecumseh's Sheboygan Falls plant in the spring/summer of 1999, characterization of the Middle River may reveal areas of more highly contaminated sediment. If during baseline characterization PCB concentrations equal to or greater than 26 ppm are found, these soft sediment deposits will be removed as they would significantly impair the overall Middle River soft sediment SWAC from achieving a PCB concentration of 0.5 ppm, or less over time. An explanation of the 26 ppm trigger is found on page 79.

An extensive monitoring program would be implemented to gauge the condition of the river and potential human health impacts over time. Long-term monitoring will provide valuable information on changing conditions that may warrant removal of PCB-contaminated sediment. Annual fish sampling will be occur until fish consumption advisories are lifted. Sediment samples will be taken every five years to document natural processes and to ensure that over time the entire river reaches an average PCB sediment concentration of 0.5 ppm, or less, and that over time fish consumption advisories will be phased out.

Lower River and Inner Harbor

Lower River

The Lower River remedy includes characterization and a PCB soft sediment SWAC of 0.5 ppm, or less over time. Unlike the Upper and Middle River segments, the Lower River contains a more continuous soft sediment river bottom. The river flow is less dynamic but soft sediment may be vulnerable to high flow events or boat traffic. Since the Lower River was never dredged by the U.S. Army Corps of Engineers like the Inner Harbor has been, the Lower River is at a state of dynamic equilibrium, meaning high flow events to boating traffic likely change the profile of soft sediments from year to year. There is no bathymetric data to show how the sediment bed has changed over time and if certain portions of the Lower River are susceptible to scour during high flow events or from boat traffic.

Using information from the RI/ES Report and Feasibility Study, a SWAC was calculated for the Lower River. This information is contained in Exhibit 6. According to the information, the Lower River soft sediment PCB SWAC is 5.5 ppm. To achieve a soft sediment PCB SWAC of 0.5 ppm, U.S. EPA estimates that 127,000 cubic yards of sediment must be removed.

As part of the aquatic risk assessment, NOAA took soft sediment samples in the Lower River in 1997. A comparison of the PCB sediment data is shown in Table 15.

Table 15 - Comparison of Lower River Surface Sediment Data (ppm)

1990 RI/ES		1997 NOAA Aquatic Risk Assessment	
Location	**PCB Concentration**	**Location**	**PCB Concentration**
R73 / R74	6.3 / 5.5	T09	0.3
R77 / R78	4.4 / 0.2	T10	0.2
R80 / R81	11.0 / 0.1	S5-4	1.0
R88	4.2	S5-5	0.6
R90 / R91	8.7 / 1.9	T11	0.2
R94	11.0	T12	0.2
R95 / R96 / R97	0.5 / 8.9 / 2.0	T13	0.4

Table 15 - Comparison of Lower River Surface Sediment Data (ppm)			
1990 RI/ES		1997 NOAA Aquatic Risk Assessment	
Location	PCB Concentration	Location	PCB Concentration
N/A	N/A	T14	0.5
N/A	N/A	T15	0.4
R98	2.3	T16	0.4
R100 / R101	5.7 / 0.9	T17	0.4

A review of the data shows that for the 10 samples NOAA obtained, PCB concentrations in surface sediment have dropped off significantly from the time sediment was obtained during the RI/ES. A Lower River SWAC cannot be recalculated using the NOAA data, because the data set is too limited. It does indicate, however, that PCB concentrations in surficial soft sediments are likely to be near 0.5 ppm or less for the Lower River and that the 0.5 ppm SWAC target may already be achieved in the Lower River. But because the more recent data is limited, the Lower River will be characterized to get an accurate picture of PCB concentrations in both surficial and sediments at depth. In addition, annual bathymetrys of the Lower River will be conducted to track sediment bed changes over time and determine if any areas of the Lower River are susceptible to scour that might disturb or resuspend soft sediment with higher concentrations of PCBs below the surface.

A prop wash analysis, for the Inner Harbor, was submitted by BBL during the public comment period indicating that soft sediments within the top 1 foot are subject to disturbance by recreational boats. The USACE reviewed the analysis and generally concurred with the conclusions of the analysis. One important assumption made in the prop wash analysis is the assumption that water depths are five feet or greater. While this is accurate for much of the Inner Harbor, a significant portion of the Lower River may have less than 5 feet of water. Since the prop wash analysis assumed a minimum water depth of 5 feet and much of the Lower River may have less than 5 feet of water, the disturbances due to prop wash may be greater than the top 1 foot calculated.

Since the river is a dynamic environment and significant time has lapsed since it was last characterized, the Lower River will be characterized to obtain an accurate picture of contaminant distribution in soft sediments and to determine if removal of PCB-contaminated soft sediment deposits is warranted. PCB-contaminated sediment in excess of 26 ppm within the top foot will be removed where water depths are greater than 5 feet and PCB-contaminated sediment in excess of 26 ppm within the top two feet will be removed where water depths are less than 5 feet. An explanation of the 26 ppm PCB trigger is on page 79. Any excavated areas of the Lower River will be backfilled with clean sediment in a manner to minimize resuspension or disturbance of any remaining contaminated sediments.

Excavation depths and volumes may be increased if through a bathymetry analysis, certain sediment areas are subject to scour greater than the effects of boat disturbance and those areas coincide with areas of high PCB concentration, or if it is determined through a re-evaluation of the Lower River sediment data that soft sediment must be removed to achieve a PCB soft sediment SWAC of 0.5 ppm. This may take the form of an Explanation of Significant Differences (ESD) or ROD Amendment. Lastly, like the Upper River reaches, since contamination is left in place, the Lower River will undergo a long-term monitoring program to assess sediment and fish tissue concentrations over time.

Inner Harbor

Like the other areas of the river, the overall goal is to achieve an overall PCB soft sediment SWAC of 0.5 ppm for this river component. The Inner Harbor is covered by a continuous layer of soft sediment. Soft sediment depths range from less than 1 foot to over 20 feet. The highest levels of PCB contamination are generally many feet below the sediment surface with lesser contaminated sediment at the surface. Although limited in quantity, surface samples (top 6 inches) obtained in 1999, by Tecumseh, showed PCB concentrations ranging from 0.38 ppm to 5.3 ppm. The range is not much different than 1987 Inner Harbor surface sampling results showing PCB concentrations between 0.17 to 5.8 ppm.

Table 16 shows PCB concentrations at various depths in the Inner Harbor. The analysis includes Inner Harbor data as far back as 1979. All sediment column data has been repositioned to account for changes in the bathymetry between the year the data was taken and 1999. The concentrations shown in Table 16 were generated by Earth Vision software and are based on sediment data from1979 through 1999. The analysis reveals that, on average, PCB surface concentrations between the Pennsylvania Avenue and 8th Street Bridges are higher than between the 8th Street Bridge and the Inner Harbor mouth. As an example, the average concentration in the top foot is estimated to be 11.8 ppm between Pennsylvania Avenue and 8th Street and 1.3 ppm between 8th Street and the Inner Harbor mouth. These estimates are based on the original data sets and would not account for concentration changes over time due to deposition, scour and mixing. However, PCB-contaminated sediment deeper than 5 or 6 feet is unlikely to have changed significantly based on an analysis of the annual bathymetry obtained by the USACE. Earth Vision estimates indicate that there are likely a number of areas of higher PCB contamination near the surface between the Pennsylvania Avenue and 8th Street Bridges than between the 8th Street Bridge and Inner Harbor mouth.

Table 16 - PCB Concentrations At Various Depths in the Inner Harbor Based on EarthVision									
Sediment Depth	Entire Inner Harbor			Penn. Avenue to 8th St.			8th St. to Harbor Mouth		
	Ave.	Min.	Max.	Ave.	Min.	Max.	Ave.	Min.	Max.
0 to 1 foot	6.5	ND	117.4	11.8	ND	117.4	1.3	ND	9.5
1 to 2 feet	7.9	ND	89.1	15.7	ND	89.1	2.4	ND	15.1
2 to 4 feet	10.7	ND	103.2	19.1	ND	103.2	4.8	ND	37.3
4 to 6 feet	13.6	ND	82.5	20.2	ND	82.1	8.9	ND	82.5
6 to 8 feet	16.3	ND	135.2	20.0	ND	92.0	13.8	ND	135.2
8 to 10 feet	18.8	ND	167.4	19.0	ND	99.9	18.7	ND	167.4
10 to 12 feet	20.8	ND	148.4	19.0	ND	109.5	22.1	ND	148.4
12 to 14 feet	23.4	ND	173.7	22.2	ND	105.2	24.2	ND	173.7

Information was obtained from the City of Sheboygan marina to determine the water depths necessary for different vessels using the marina. Table 17 shows the approximate percentage of water depth necessary for motor boats and sailboats using the marina.

Table 17 - Inner Harbor Recreational Boat Stats

Water Depth	Motor Boats	Sail Boats
10 feet	99.9%	99.9%
7 feet	99.9%	95%
5 feet	80%	70%

Water depths in the Inner Harbor range from approximately 1 foot to 17 feet, with the shallower water depths found between the Pennsylvania Avenue and 8th Street Bridges. As mentioned earlier, the prop wash analysis submitted by BBL computed that the top 1 foot of sediment is vulnerable to disturbances from boats. The prop wash analysis assumed a minimum water depth of 5 feet which is generally accurate for the Inner Harbor except for an area near the Pennsylvania Avenue Bridge or on the inside bend near the 8th Street Bridge as seen in Figure 6.

An analysis of bathymetric surveys produced by the USACE, showed that over the last 20 years, the Inner Harbor has been primarily depositional in nature with over 185,000 cubic yards of additional sediment settling into the Inner Harbor. See Figure 7. However, very little deposition has occurred between the Pennsylvania Avenue and 8th Street Bridges since 1991. In fact, some areas have undergone as much as 3 to 4 feet of scour. On the other hand, Figure 8, shows that since 1991 up to 3 to 4 feet of additional deposition has occurred between the 8th Street Bridge and the Inner Harbor mouth.

Dividing the 20 year period into shorter time intervals reveals that deposition and scour are scattered and sometimes cyclical. Areas scoured one year get filled in the next and vice versa. As seen in Figure 9, between 1997 and 1998, a significant portion of the entire Inner Harbor underwent scour. As seen in Figure 10, between 1998 and 1999 scour and deposition areas were less significant. Based on the review of Inner Harbor bathymetrys, burial of contaminated sediments will not be significant between the Pennsylvania Avenue and 8th Street Bridges, or for approximately 40 percent of the Inner Harbor. This area of the Inner Harbor is likely near it's dynamic equilibrium. Between the 8th Street Bridge and Inner Harbor mouth, water depths are generally 10 feet or greater and additional deposition is expected to continue to occur. The bathymetric analyses show that scour has occurred within the Inner Harbor. The maximum storm event that occurred during the period when bathymetric measures were recorded was a 34-year storm event in 1998 (Holmstrom, B.K., Olson, D.L. and

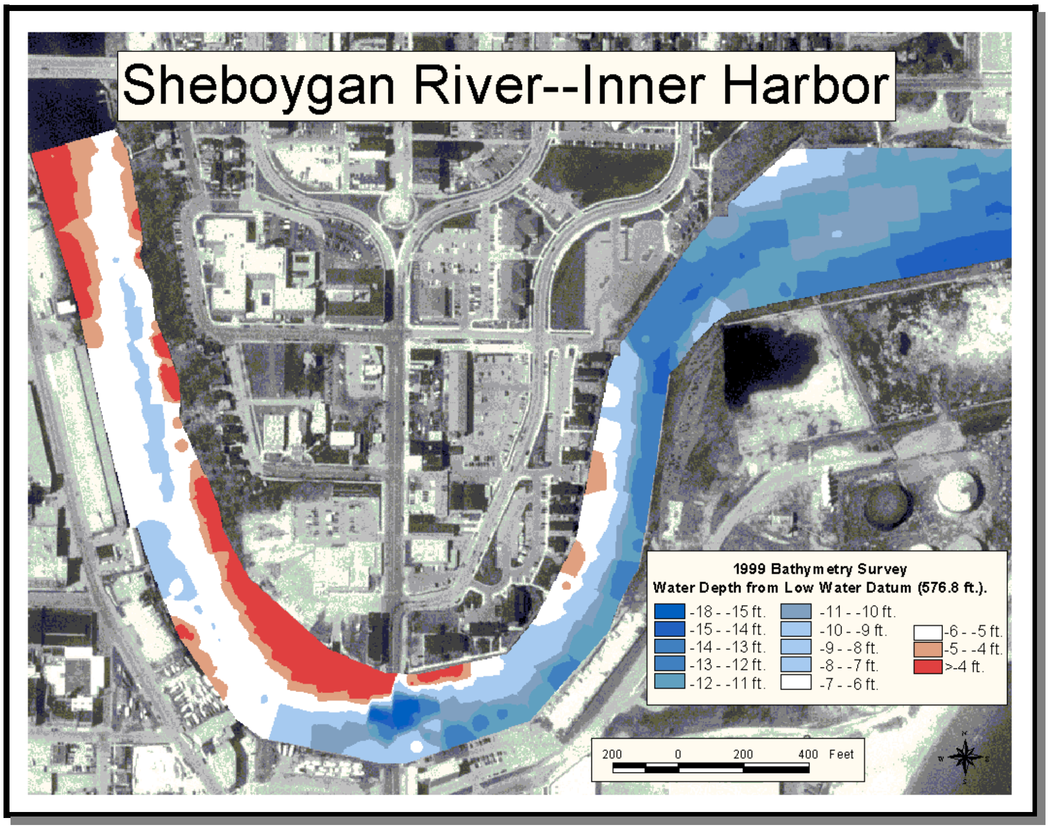
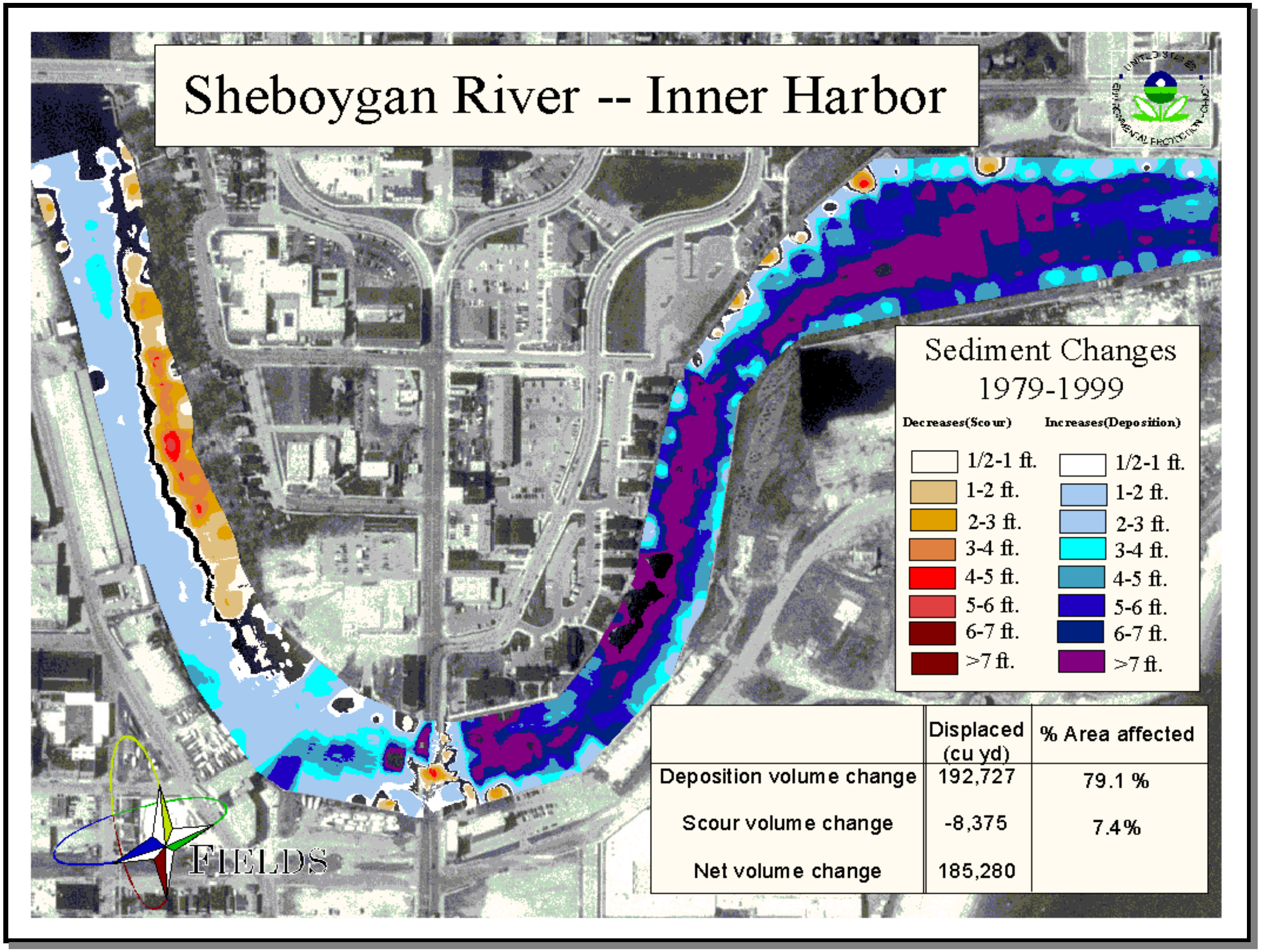


Figure 6

Ellefson, B.R., 1998, Water Resources Data Wisconsin Water Year 1998: U.S. Geological Survey Water - Data Report WI-98-1, pages 5 & 6).



	Displaced (cu yd)	% Area affected
Deposition volume change	192,727	79.1 %
Scour volume change	-8,375	7.4%
Net volume change	185,280	

Figure 7

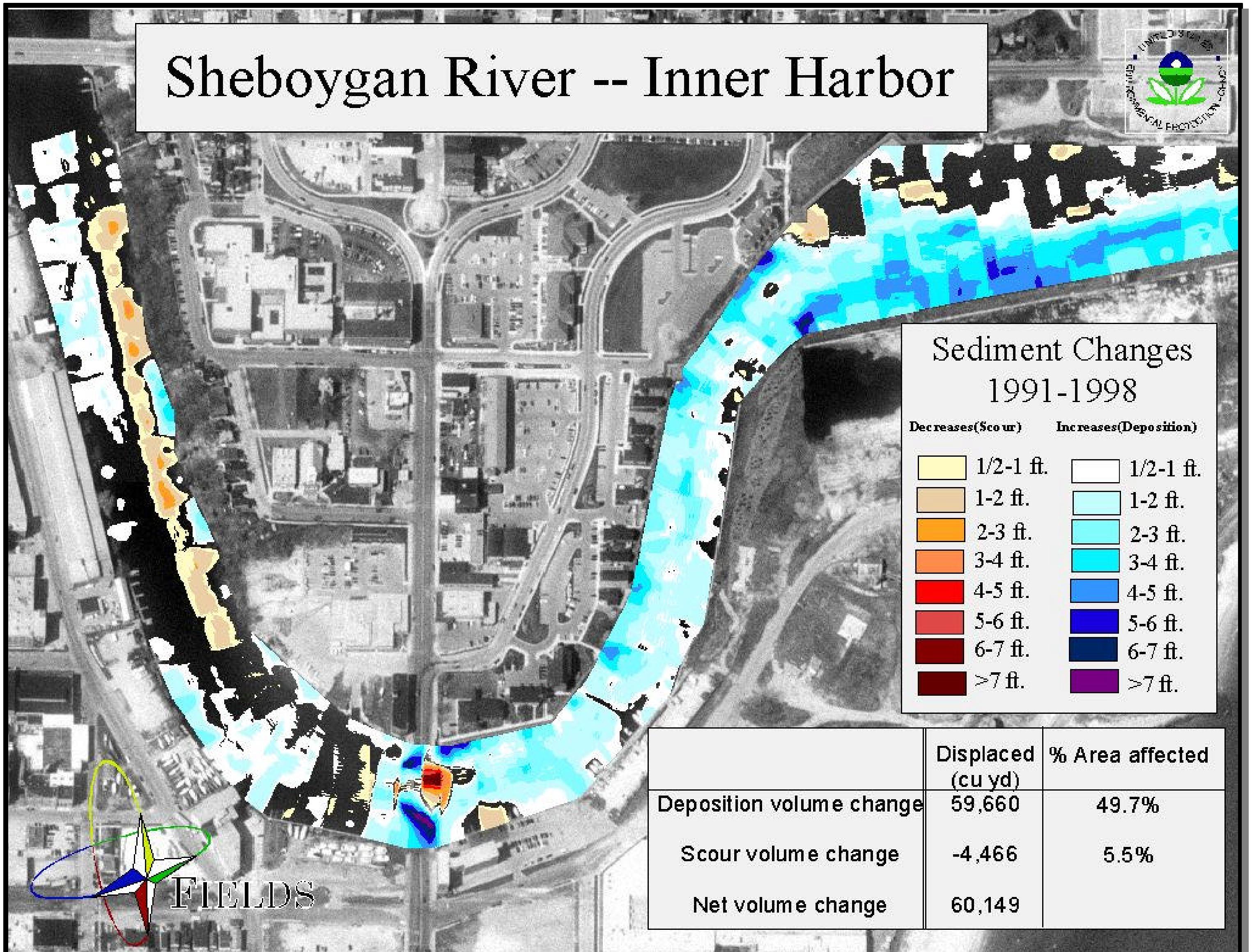
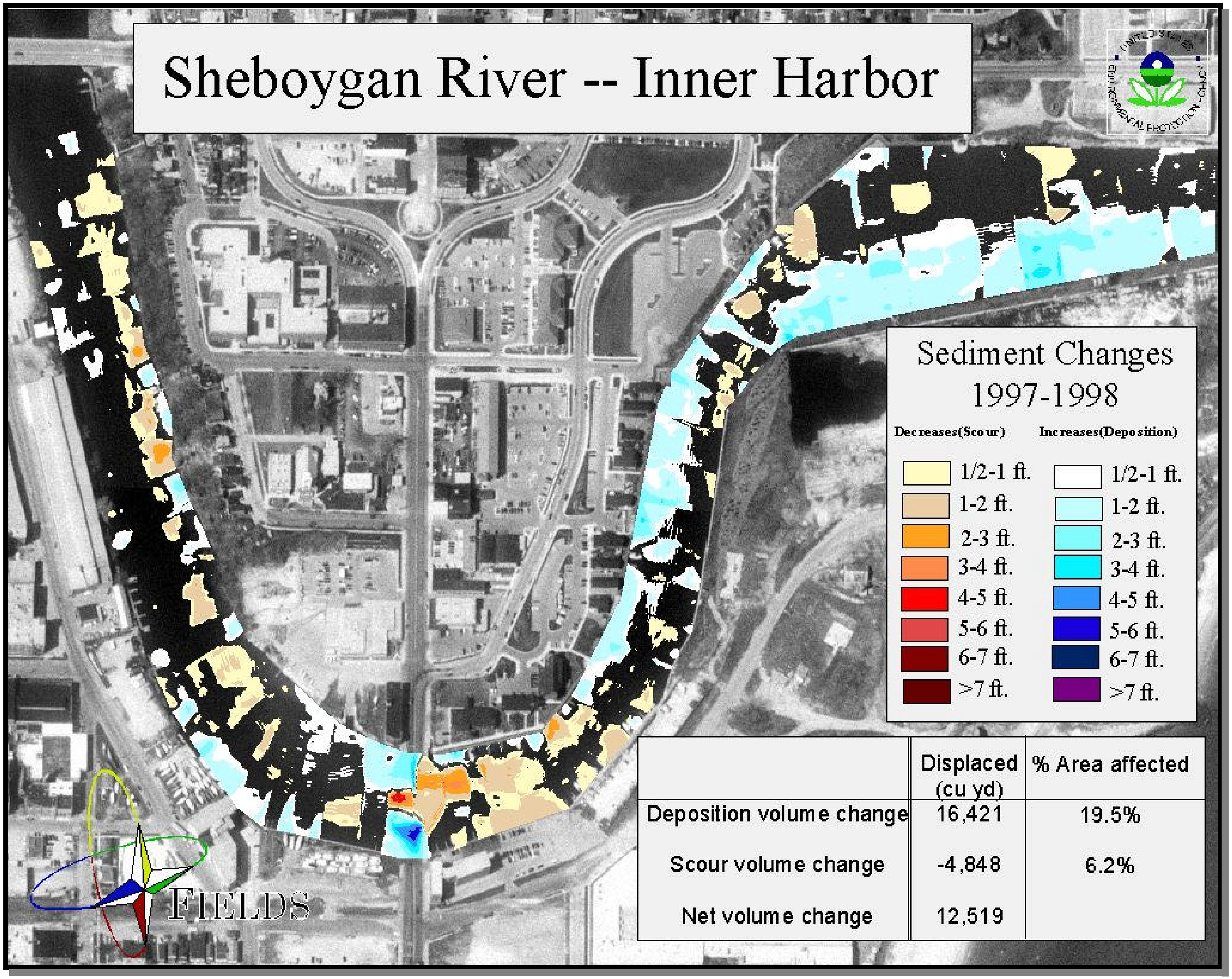

Sheboygan River -- Inner Harbor
Sediment Changes
1991-1998
Decreases(Scour)
Increases(Deposition)
1/2-1 ft.
1-2 ft.
2-3 ft.
3-4 ft.
4-5 ft.
5-6 ft.
6-7 ft.
>7 ft.
1/2-1 ft.
1-2 ft.
2-3 ft.
3-4 ft.
4-5 ft.
5-6 ft.
6-7 ft.
>7 ft.
Displaced (cu yd)
% Area affected
Deposition volume change
59,660
49.7%
Scour volume change
-4,466
5.5%
Net volume change
60,149
FIELDS

Figure 8



	Displaced (cu yd)	% Area affected
Deposition volume change	16,421	19.5%
Scour volume change	-4,848	6.2%
Net volume change	12,519	

Figure 9

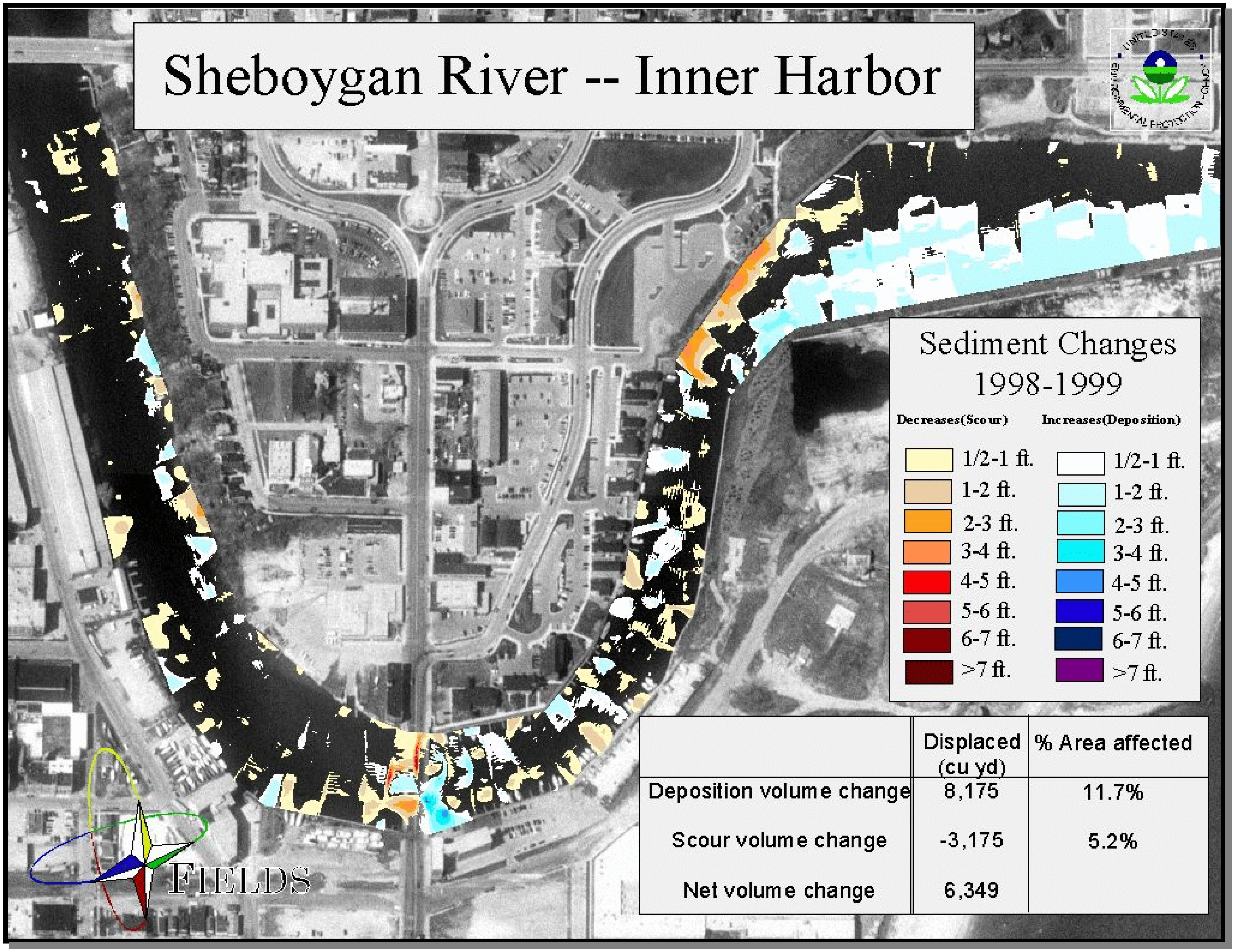

Sheboygan River -- Inner Harbor
Sediment Changes
1998-1999
Decreases(Scour)
Increases(Deposition)
1/2-1 ft.
1-2 ft.
2-3 ft.
3-4 ft.
4-5 ft.
5-6 ft.
6-7 ft.
>7 ft.
1/2-1 ft.
1-2 ft.
2-3 ft.
3-4 ft.
4-5 ft.
5-6 ft.
6-7 ft.
>7 ft.
Displaced (cu yd)
% Area affected
Deposition volume change
8,175
11.7%
Scour volume change
-3,175
5.2%
Net volume change
6,349
FIELDS

Figure 10

Based on this information and evaluating the existing alternatives, the U.S. EPA selects Alternative 4: Lower River and Inner Harbor Sediment Removal Subject to Natural and Recreational Disturbances.

U.S. EPA estimates that 53,000 yards of contaminated sediment in the Inner Harbor will be dredged so that the Lower River and Inner Harbor surface sediments will achieve a PCB concentration of 0.5 ppm, or less, on average over time. Prior to any dredging, characterization of the Lower River and Inner Harbor will be conducted to delineate PCB concentrations at depth.

Lower River & Inner Harbor Selected Remedy: Alternative 4

Estimated Capital Cost: $12.1 million
Annual O & M Cost: $201,300 or 237,000
Duration of O & M: 30 years
Total Present Value (7% discount rate): $10.0 Million
Estimated Time to Implement: 24 months

Portions of the Lower River may contain contaminated sediment that would impair surface sediments from achieving a 0.5 ppm average over time. Characterization of the sediment will be conducted to determine if any of these contaminated sediment areas currently exist. Contaminated sediment with concentrations greater than 26 ppm within the top 2 feet will be removed. If any of these areas are present, existing data shows that they are likely to be either near the Camp Marina Area, upstream of the Pennsylvania Avenue Bridge or near the island just upstream of the New Jersey Avenue Bridge.

Any dredged sediment in the Lower River and Inner Harbor will be dewatered, stabilized, and disposed of in either a WDNR-approved in-state landfill or out-of-state hazardous waste landfill depending the PCB concentration. Any excavated areas of the Lower River and Inner Harbor will be backfilled with clean sediment in a manner to minimize resuspension or disturbance of contaminated sediments. Annual bathymetric surveys of the Lower River and Inner Harbor will be conducted to assess sediment profile changes and determine if buried PCB-contaminated sediment, equal to or greater than 26 ppm, is vulnerable to disturbance and release.

The Inner Harbor remedy includes characterization and removal of 2 feet of contaminated sediment from the Pennsylvania Avenue Bridge to just past the 8th Street Bridge which is depicted as Area A in Figure 11. Area A is vulnerable to prop wash effects and/or scour. Based on the existing data, PCB concentrations within the top 2 feet of Area A are high enough to keep the Inner Harbor from reaching a PCB SWAC of 0.5 ppm, or less over time. Area A represents about 45 percent of the Inner Harbor and with very little additional deposition likely to occur in this area, the remaining 55 percent of the Inner Harbor would have to reach PCB concentrations near non-detect levels for the entire Inner Harbor to average 0.5 ppm overall.

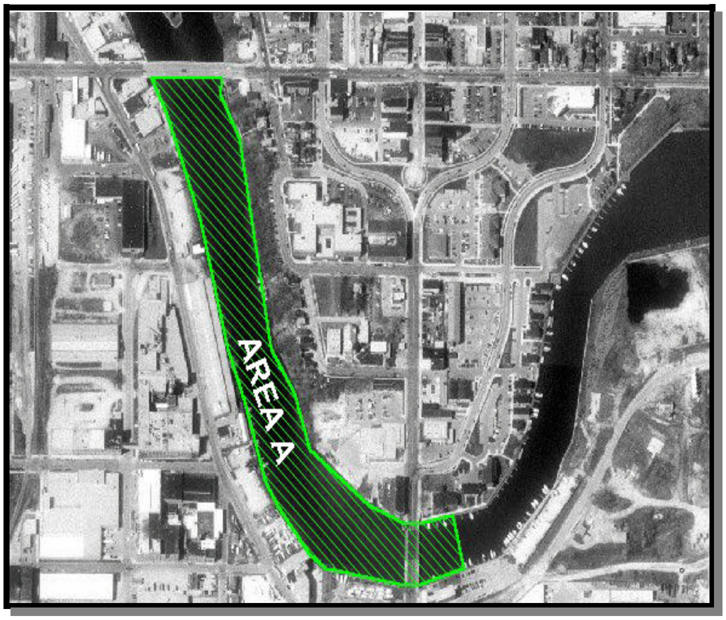


Figure 11

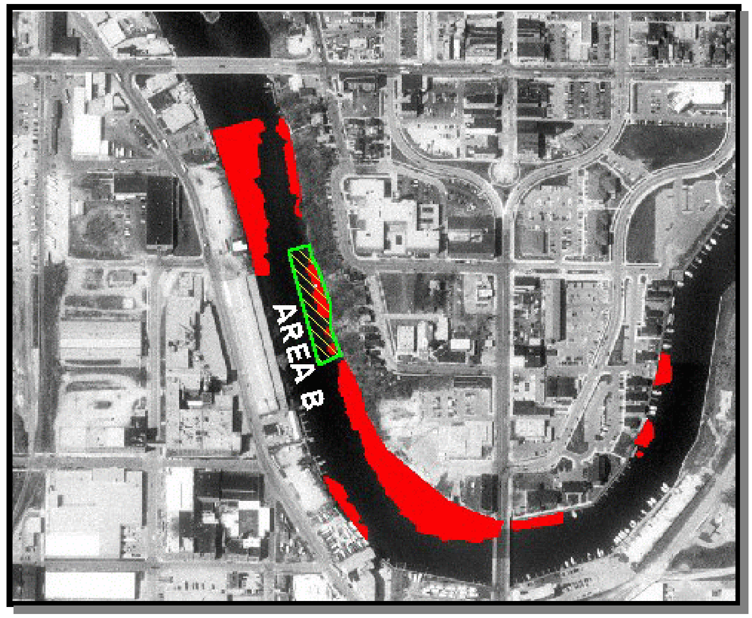


Figure 12

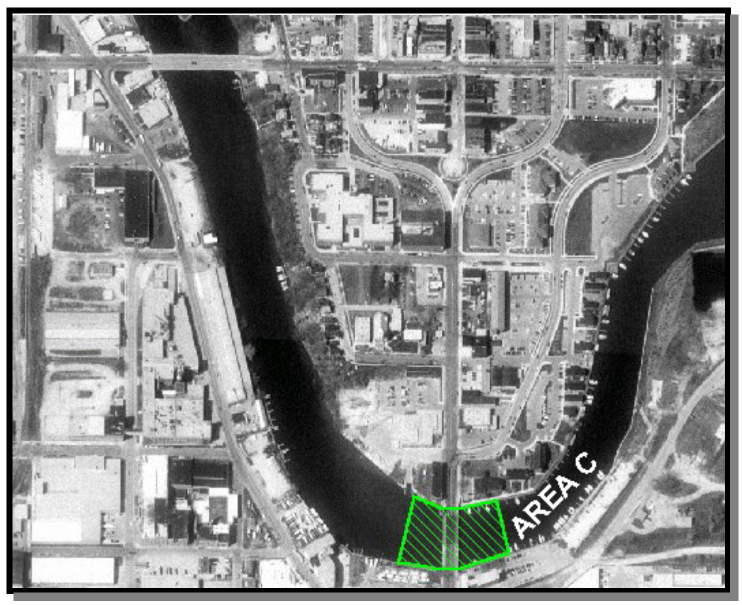


Figure 13

An additional two feet of sediment will be removed in those areas of the Inner Harbor where the bathymetry analysis shows scour greater than 2 feet. These areas are noted as Area B in Figure 12 and Area C in Figure 13. Figure 12 also shows what areas of the Inner Harbor that have less than 5 feet of water depth based on the low water datum.

Characterization of PCB contamination may also reveal that areas between the 8th Street Bridge and the Inner Harbor mouth contain PCB concentrations above 26 ppm in areas historically vulnerable scour or within the top foot of the sediment surface. Under these circumstances, contaminated sediment will also be removed between the 8th Street Bridge and the Inner Harbor mouth.

The USACE is authorized to model the fate and transport of sediments for all the Great Lakes Areas of Concern. Modeling for the Sheboygan River is projected to take place prior to implementation of the selected remedy for the Inner Harbor. This modeling is required by Section 516(e) of the Water Resources Development Act of 1996. Data collected during the design phase could be used for this modeling effort. If the modeling results clearly demonstrate increased scour in the Inner Harbor, the remedy will be reevaluated.

Lastly, to keep the most highly contaminated sediment in place, maintenance of the Outer Harbor breakwalls is necessary. Like the other river segments, a long-term monitoring program will be implemented to assess sediment and fish tissue levels over time. If over time it is determined that PCB-contaminated sediment, equal to or greater than 26 ppm, is being exposed or showing up in areas of the Lower River and Inner Harbor that are vulnerable to boat effects and/or scour, these contaminated sediments will be removed and backfilled/covered with clean sediment.

Annual fish sampling will occur until fish consumption advisories are lifted. Sediment samples will be taken at least once every five years to document natural processes and to ensure that over time the entire river will reach an average PCB sediment concentration of 0.5 ppm, or less, and that over time fish consumption advisories will be phased out. Fish and waterfowl consumption advisories will remain in place until monitoring indicates they can be dropped.

Selection of the 26 ppm PCB Trigger

In determining what concentration of PCBs or what mass of PCB would constitute a substantial threat to achieving an overall SWAC of 0.5 ppm for the Lower River and Inner Harbor, U.S. EPA developed a geostatistical sediment sampling design that yielded a specific sampling frequency. U.S. EPA determined that a substantial threat to achieving a 0.5 ppm SWAC, over time, would be the release of PCBs that would re-contaminate a surface area representing 20% or more of the Inner Harbor. Since the overall PCB sediment goal is a SWAC of 0.5 ppm, over time, U.S. EPA determined that the release of enough PCBs, over 20% of the harbor, to create an overall Inner Harbor PCB surface sediment concentration of 2.0 ppm in the biologically active zone to be unacceptable. Given the geostatistical sampling approach, mentioned earlier, each sediment sample represents a 8,432 ft^2 area. U.S. EPA has estimated the depth of sediments that can be disturbed by boat traffic or high flow events is approximately 2 feet.

Dividing the calculated mass by the representative volume of each sample, equals a sediment sample concentration of 26 ppm. This means that if a sediment sample is taken and has a PCB concentration of 26 ppm or higher, the 16,864 ft^3 (625 yd^3) volume needs to be addressed for appropriate response action. That could be removal of the 625 yd^3 area or more detailed delineation of the sediment area to determine what volume of the area has PCB concentrations greater than 26 ppm. A more detailed explanation and the actual calculations for the trigger can be found in the Administrative Record.

Floodplain Soil

Based on the U.S. EPA terrestrial assessment and the ecological risks presented in this ROD, the U.S. EPA selects Alternative 4: Removal of Soil Containing PCB concentrations greater than 10 ppm.

> ***Floodplain Selected Remedy: Alternative 4***
>
> *Estimated Capital Cost: $4.7 million*
> *Annual O & M Cost: $29,800*
> *Duration of O & M: 30 years*
> *Total Present Value (7% discount rate): $4.5 Million*
> *Estimated Time to Implement: 30 months*

Floodplain soil containing PCB concentrations greater than 10 ppm will be excavated and disposed of off-site at an approved TSCA landfill. Before initiating excavation, associated access roads and river access will be constructed as necessary. To further refine the extent of floodplain soil containing PCBs greater than 10 ppm, additional sampling will be performed. Upon completion of the soil removal activities, the affected areas will be restored in an appropriate manner including replacement of the excavated soil, seeding, restoration of any fencing and planting of trees. Any soil/grubbed material will be loaded onto transport trucks and the soil taken off-site for disposal at an approved TSCA facility. If appropriate, cleared material, like trees, will be chipped and used for landscaping mulch. If this is not possible cleared material will be disposed off-site in a local Wisconsin solid waste landfill. The removal of PCB-contaminated soil will be balanced with maintaining existing high quality ecological habitat. Lastly, long-term monitoring of the floodplain soil will be conducted.

Ground-water & Additional Source Investigation

Based on information in the Feasibility Study and information presented in this ROD, the U.S. EPA selects Alternative 2: Investigation/Source Identification and Control

> ***Groundwater Selected Remedy: Alternative 2***
>
> *Estimated Capital Cost: $313,000*
> *Annual O & M Cost: $21,000*
> *Duration of O & M: 30 years*
> *Total Present Value (7% discount rate): $594,000*
> *Estimated Time to Implement: 12 months*

Current PCB concentrations in the existing facility monitoring wells will be assessed. If the ground-water sampling determines that PCB are present in ground-water at Tecumseh's Sheboygan Falls plant, additional borings/monitoring wells will be installed to further define the lateral extend of ground-water that contains PCBs and to more closely assess the hydrogeologic parameters at Tecumseh's Sheboygan Falls plant. The hydrogeologic parameters that will be targeted for evaluation include horizontal hydraulic gradient, vertical hydraulic gradient, nature of the ground-water/surface water interaction, including the possible effects of the flood control berm, and temporal variations in ground-water flow direction. The additional borings also will be used to further assess the stratigraphy of the subsurface at Tecumseh's Sheboygan Falls plant. Information necessary to conduct a natural recovery evaluation will be collected.

In conjunction with evaluating ground-water to surface water migration, an investigation will be performed to identify potential PCB sources to ground-water under Tecumseh's Sheboygan Falls plant, or to the Sheboygan River directly. This will include an investigation of existing sewer lines that may be preferential pathways for PCBs into the river. Investigations in 1999 indicated high levels of PCBs in the river bank near Tecumseh's Sheboygan Falls plant . Source removal / control will be required depending on the results of these investigations. Long-term monitoring of Tecumseh's Sheboygan Falls plant ground-water and river bank sampling near Tecumseh's Sheboygan Falls plant will be conducted to ensure that no additional PCB sources to the river exist. If it is determined that ground-water under the Tecumseh plant is venting into surface water, and natural recovery is not appropriate as a final ground-water remedy, or preferential pathways from the Tecumseh plant to the river cannot be removed, Ground-water Alternative 3: Collection Trench and Treatment will be implemented.

Placement of an institutional control to limit access to Tecumseh's Sheboygan Falls plant ground-water as a drinking water source will be implemented.

Summary of the Estimated Remedy Costs

Cost Element	**Upper River**	**Middle River**	**Lower River & Inner Harbor**	**Floodplain Soil**	**Ground-water Investigations/ Source Control**
Estimated Capital Cost:	$30,600,000	$0	$12,100,000	$4,700,000	$313,000
Annual O & M Cost:	Varies	Varies	Varies	$29,800	$21,000
Total Present Value (7% discount rate):	$23,800,000	$2,000,000	$10,000,000	$4,500,000	$600,000

Expected Outcomes of Selected Remedy

Removal of PCB-contaminated sediment in the Upper River, Middle River, Lower River and Inner Harbor are expected to achieve a soft sediment SWAC of 0.5 ppm or less upon completion of the remedy or shortly thereafter. Removal of PCB-contaminated floodplain soil will achieve a soil SWAC of 10 ppm or less upon completion of the remedy. Source identification and control or a collection trench and treatment will reduce PCB loading to the Sheboygan River. Implementation of the entire remedy will reduce PCB fish tissue levels such that fish consumption advisories in the river and harbor can be revised. Over the long term, PCB reductions in sediment will reduce chronic and toxic stress on the benthic populations in the river. Reduced sediment toxicity will improve Sheboygan River and Lake Michigan fish spawning conditions. Sediment habitat will be improved such that benthos and wildlife populations will improve, known reproductive impacts on wildlife populations will be diminished.

Dredging in the harbor will significantly reduce resuspension of PCB contaminated sediment from high flow events or boats which will limit the available mass and concentrations of domestic and industrial waste sludges, nutrients, and toxic metals now found in the sediments leading to generally improved conditions in water quality. The selected remedy will reduce PCB loadings to Lake Michigan.

M. <u>STATUTORY DETERMINATIONS</u>

Under CERCLA Section 121 and the NCP, the U.S. EPA must select remedies that are protective of human health and the environment, comply with applicable or relevant and appropriate requirements (unless a statutory waiver is justified), are cost effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity or mobility of hazardous wastes as a principal element and a bias against off-site disposal of untreated wastes. The following sections discuss how the selected remedy meets these statutory requirements.

Protection of Human Health and the Environment

Implementation of the selected remedy will adequately protect human health and the environment through the removal and off-site disposal of PCB-contaminated sediment, removal and off-site disposal of PCB-contaminated floodplain soil, and the identification and control of PCB-contaminated ground-water and potential additional PCB sources. The selected remedy will be required to achieve a soft sediment SWAC of 0.5 ppm which equates to a risk of 1.0×10^{-4} for human health and between the NOAEL and LOAEL for the aquatic receptors evaluated. Removal of PCB-contaminated soft sediment will result in an overall river PCB concentration within acceptable risk ranges. While the sediments in the Middle River are not being addressed, this should not impair the entire site from reaching the acceptable risk range. Finally, the selected remedy does not pose unacceptable short-term risk.

Compliance with ARARs

Section 121(d) of CERCLA requires that Superfund remedial actions meet ARARs. In addition to ARARs, the ARARs analysis which was conducted considered guidelines, criteria, and standards useful in evaluating remedial alternatives. These guidelines, criteria, and standards are known as "To Be Considered" (TBCs). In contrast to ARARs, which are promulgated cleanup standards, standards of control, and other substantive environmental protection requirements, criteria or limitations; TBCs are guidelines and other criteria that have not been promulgated. The selected remedy will comply with the ARARs and the TBCs listed in Table 19.

Potential Chemical-Specific ARARs

Toxic Substances Control Act (TSCA): TSCA establishes requirements for the handling, storage, and disposal of PCB-containing materials in excess of 50 ppm. TSCA is an ARAR at the site with respect to any PCB-containing materials with PCB concentrations in excess of 50 ppm that are removed from the site. Pursuant to TSCA, the U.S. EPA has promulgated a PCB spill cleanup policy that set forth cleanup criteria for PCB releases that occurred after May 4, 1987. The soil cleanup levels set forth in the policy are 10 ppm for areas of unrestricted access and 25 ppm for locations where access is restricted. The criteria are not directly applicable to the site given the historical nature of the PCB releases in the Sheboygan River (i.e. in the river pre-date the 1987 "cut-off" date). The TSCA PCB spill policy is treated as a TBC for this site as it may provide guidance on addressing soil-related PCB cleanups.

Clean Water Act: Federal surface water quality standards are adopted under Section 304 of the Clean Water Act where a state has not adopted standards. These federal standards, if any, are ARARs for point discharges to the river. Related to these standards are the federal ambient water quality criteria. These criteria are non-enforceable guidelines that identify chemical levels for surface waters and generally may be related to a variety of assumptions such as use of a surface water body as a water supply. These criteria may be TBCs for this site.

Ground-water Quality Standards: State ground-water quality standards for various chemical are set forth in Wisconsin Administrative Code Section NR 140. In general, NR 140.24 and NR 140.26 require preventive action limits (PALs) to be achieved to the extent it is technically and economically feasible to do so. In the remediation context, the environmental standard is to be achieved within a reasonable timeframe. Natural attenuation is allowed as a remedial method where source control activities have been undertaken. The ground-water quality standards constitute an ARAR.

Soil Cleanup Standards: The State of Wisconsin has adopted generic, site-specific, and performance-based soil cleanup standards. These regulations allow the party conducting the remedial action to select which approach to apply. The soil standards are divided into those necessary to protect the ground-water quality and those necessary to prevent unacceptable, direct contact exposure. Generic soil standards, based on conservative default values and assumptions, have been adopted only for a few substances, none of which are relevant to the site. Site-specific soil standards depend upon a variety of factors, including local soil conditions, depth to ground-water, type of chemical, access restrictions, and current and future use of the property. These site-specific soils standards also may be adjusted based on an assessment of the site-specific risk presented by the chemical constituents of concern. With respect to the site, the soil standards constitute an ARAR.

Surface Water Quality Standards: The State of Wisconsin has promulgated water quality standards which are based on two components; 1) use designation for the water body; and 2) water quality criteria. These standards, designations, and criteria are set forth in Wisconsin Administrative Code Sections NR 102 to NR 105. The state also has rules for applying the water quality standards when establishing water-quality-based effluent limits (NR 106, NR 207). The state water quality standards are used in making water management decisions and controlling municipal, business, land development, and agricultural activities (NR 102.04, Wis. Admin. Code). In the remediation context, surface water quality standards are applicable to point source discharges that may be part of the remedial action. Further, to the extent the remedial work is conducted in or near a water body, such work is to be conducted so as to prevent or minimize an exceedance of a water quality criterion (NR 102 to 105).

As recognized in the WDNR's sediment guidance (1995), the water quality standards are goals to be used in guiding the development of the sediment remediation work. As a goal, but not a legal requirement, the water quality standards as applied to the remediation of sediment contamination constitute a TBC.

In addition, the NCP states that, in establishing Remedial Action Objectives (RAOs), water quality criteria established under the Clean Water Act (WQSs in Wisconsin), shall be attained where "relevant and appropriate under the circumstances of the release." 40 C.F.R. Section 300.430(e)(2)(I)(E).

The Agency has determined that WQS's, while relevant to sediment clean up RAOs, are not appropriate for direct application at this time. Calculating a site specific sediment quality standard from a WQS using current scientific methods such as equilibrium partitioning is very uncertain. Moreover, the Agency's 1996 Superfund PCB clean up guidance directly addresses sediment clean up targets using water quality criteria. The guidance suggests using equilibrium partitioning to develop a sediment criteria and then compare it to risk based clean up numbers for establishing an RAO as would be done with a non-ARAR. If the guidance considered a derived sediment quality number to be an ARAR, it would be directly applied to each alternative as a threshold criteria. Therefore, WQSs are not ARARs and are not a threshold criteria for selecting an alternative at the site.

Potential Action- and Location-Specific ARARs

Wisconsin Statutes Chapter 30: Chapter 30 of the Wisconsin Statutes requires permits for work performed in navigable water on or near the bank of such a waterway. Under CERCLA, only the substantive provisions set forth in Chapter 30 (as opposed to the need for a permit) must be satisfied. In general, the substantive provisions address minimizing any adverse effects on the waterway that may result from the work. The substantive provisions are action-specific ARARs.

Section 10 - Rivers and Harbors Act; Section 404 - Clean Water Act: Section 404 of the Clean Water Act requires approval from the USACE for discharges of dredged or fill material into waters of the United States, and Section 10 of the Rivers and Harbors Act requires approval from the USACE for dredging and filling work performed in navigable waters of the United States. As the Sheboygan River is a water of the United States, these statutes might implicate action-specific ARARs for dredging/filling work which may be conducted in the river. Under the Fish and Wildlife Coordination Act, the USACE must coordinate with the Fish and Wildlife Service regarding minimization of effects from such work. The work would be subject to the substantive environmental law aspects of permits under these statutes, which would be ARARs. Permits are not required under CERCLA.

Floodplain and Wetland Regulations and Executive Orders 11988 and 11990: The requirements of 40 C.F.R. § 264.18 (b) and Executive Order 11988, Protection of Flood Plains, are relevant and appropriate to action on the site. Executive Order 11990 (Protection of Wetlands) is an applicable requirement if there are any wetlands present in the areas to be remediated.

National Historic Preservation Action (NHPA), 16 U.S.C. 470 et seq: The National Historic Preservation Act (NHPA) provides protections for historic properties (cultural resources) on or eligible for inclusion on the National Historic Register of Historic Places (see 36 C.F.R. Part 800). In selecting a remedial alternative, adverse effects to such properties are to be avoided. If any portion of the site is on or eligible for the National Historical Register, the NHPA requirements would be ARARs.

Endangered Species: Both State and Federal law have statutory provisions that are intended to protect threatened or endangered species [i.e., Endangered Species Act (Federal) and Fish and Game (State)]. In general, these laws require a determination as to whether any such species (and its related habitat) reside within the area where an activity under review by governmental authority may take place. If the species is present and may be adversely affected by the proposed activity, where the adverse effect cannot be prevented, the proposed action may proceed. If threatened or endangered species exist in certain areas of the Sheboygan River, these laws may constitute an action-specific ARAR. At the site, the queen snake as well as several plant species were noted by WDNR to be endangered/rare resources occurring within or near the site.

Management of PCBs and Products Containing PCBs: Wisconsin regulations [i.e., Management of PCBs and Products Containing PCBs (Wisconsin Administrative Code § NR 157) that were adopted pursuant to section 299.45. Wisconsin Statutes] which establish procedures for the storage, collection, transport, and disposal of PCB-containing materials also would apply to remedial actions taken at the site.

Solid Waste Management Statutes and Rules (Chapter 289, Wisconsin Statutes and Wisconsin Administrative Code §§ NR 500-520, Wis. Admin. Code] establish standards that apply to the collection, transportation, storage and disposal of solid waste.

TSCA - Disposal Approval: Under TSCA, U.S. EPA may grant generic approvals for disposal of PCB-containing materials (subject to certain limitations and exceptions). U.S. EPA has granted an approval to Wisconsin allowing the disposal of PCB-containing sediments up to 50 ppm PCBs in a state-of-the-art Wisconsin licensed solid waste facility. If PCB-containing sediments are disposed from the site, this U.S. EPA approval would constitute an ARAR with respect to disposal location.

Additional To Be Considered Information

Section 303(d), Clean Water Act: Under Section 303(d) of the Federal Clean Water Act, states are required, on a periodic basis, to submit lists of “impaired waterways” to U.S. EPA. In December 1996, WDNR submitted its first list of impaired waters under Section 303(d). The Sheboygan River was included on the initial list. WDNR has taken no further action with respect to the listing, nor has it developed a total maximum daily load (TMDL) for the river. Currently, a State-wide watershed committee is advising WDNR on the steps to be taken in this process, and the listing process is being reviewed by the Wisconsin Natural Resources Board. The listing of the Sheboygan River under Section 303(d) is a TBC.

Great Lakes Water Quality Initiative, Part 132, Appendix E: The Great Lakes Water Quality Initiative set forth guidance to the states bordering the Great Lakes regarding their wastewater discharge programs. For remedial actions, the guidance states that any remedial action involving discharges should, in general, minimize any lowering of water quality to the extent practicable. The concepts of the guidance have been incorporated into Wisconsin Administrative Code § NR 102 to § NR 106. The Great Lakes Water Quality Initiative constitutes a TBC.

Sediment Remediation Implementation Guidance: Part of the Strategic Directions Report of WDNR approved by Secretary Meyer in 1995 addressed the sediment remediation approach to be followed by WDNR. This approach includes meeting water quality standards as a goal of sediment remediation projects. In developing a remedial approach, the guidance calls for use of a complete risk management process in consideration of on-site and off-site environmental effects, technological feasibility, and costs. The guidance constitutes a TBC.

Great Lakes Water Quality Agreement: The Great Lakes Water Quality Agreement calls for the identification of “Areas of Concern” in ports, harbors, and river mouths around the Great Lakes. Remedial goals to improve water quality are to be established in conjunction with the local community. In Sheboygan, a Remedial Action Plan (RAP) was prepared and finalized in 1995. The RAP lists a series of recommendations ranging from addressing contaminated sediments to controlling non-point source runoff. This is a TBC.

Sheboygan River Basin Water Quality Management Plan: This plan was developed by WDNR and lists management objectives for improving water quality in the Sheboygan River Basin. This is a TBC.

Table 18 - Sheboygan River and Harbor ARARs	
Act / Regulation	Citation
Federal Chemical-Specific ARARs	
TSCA	40 CFR 761.60(a)(5)-761.79 and U.S. EPA Disposal Approval
Clean Water Act - Federal Water Quality Standards	40 CFR 131 (if no Wisconsin regulation) and 33 CFR 323
Federal Action-/Location - Specific ARARs	
Fish and Wildlife Coordination Act	16 USC 661 *et seq.* 33 CFR 320-330-Rivers and Harbors Act 40 CFR 6.304
Endangered Species Act	16 USC 1531 *et seq.* 50 CFR 200 50 CFR 402
Rivers and Harbor Act	33 USC 403; 33 CFR 322, 323
National Historic Preservation Act	15 USC 470; *et seq.* 36 CFR Part 800
Floodplain and Wetlands Regs & Executive Orders	40 CFR 264.18 (b) and Executive Order 11988
State Chemical-Specific ARARs	
TSCA-Disposal Approval	U.S. EPA Approval
Surface Water Quality Standards	NR 106 and 207 NR 722.09 1-2
Ground-Water Quality Standards	NR 140
Soil Cleanup Standards	NR 720 and 722
Hazardous Waste Statutes and Rules	NR 500 - 520
State Action- / Location-Specific ARARs	
Management of PCBs and Products Containing PCBs	NR 157
Solid Waste Management	NR 500-520
Navigable Waters, Harbors, and Navigation	Chapter 30 - Wisconsin Statutes
Fish and Game	Chapter 29.415 - Wisconsin Statutes

Cost-Effectiveness

U.S. EPA has determined that the selected remedy is cost effective. Section 300.430 (f)(1)(ii)(D) of the NCP requires U.S. EPA to evaluate cost effectiveness by comparing all the alternatives that meet the threshold criteria (protection of human health and the environment and compliance with ARARs) against three balancing criteria (long-term effectiveness and permanence, reduction of toxicity, mobility or volume through treatment, and short-term effectiveness). The selected remedies meet these criteria by achieving a permanent protection of human health and the environment at low risk to the public, and provide for overall effectiveness in proportion to their cost.

The Superfund program does not mandate the selection of the most cost effective cleanup alternative. The most cost effective remedy is not necessarily the remedy that provides the best balance of tradeoffs with respect to the remedy selection criteria nor is it necessarily the least-costly alternative that is both protective of human health and the environment and ARAR-compliant. Cost effectiveness is concerned with the reasonableness of the relationship between the effectiveness afforded by each alternative and its costs compared to other available options.

The total net present worth of the selected remedy is $40,900,000. Although Upper River alternative 3-II and Floodplain Soil alternative 2, the PRP preferred alternatives, are less expensive than the U.S. EPA selected alternatives, 3-IV-A and 4 respectively, the additional mass removed under the selected remedy provides a significant increase in overall protection of human health and the environment to meet the threshold risk target range and is cost effective. In addition, while the PRP preferred alternative for the Lower River and Harbor, alternative 2, is less expensive than the U.S. EPA alternative, alternative 4, the U.S. EPA alternative will remove the PCB-contaminated sediments most vulnerable to resuspension due to recreational uses and high river flow events. Continued maintenance of the Inner Harbor breakwalls will effectively contain the more highly PCB-contaminated sediments buried at depth that are not vulnerable to human or natural disturbances.

Utilization of Permanent Solutions and Alternative Treatment Technologies or Resource Recovery Technologies to the Maximum Extent Practicable

U.S. EPA believes that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a cost-effective manner for the Sheboygan River and Harbor site. The selected remedy does not pose excessive short-term risks. There are no special implementability issues that set the selected remedy apart from the other alternatives evaluated.

Preference for Treatment as a Principal Element

Based on current information, U.S. EPA believes that the selected remedy is protective of human health and the environment and utilizes permanent solutions to the maximum extent possible. The remedy, however, does not satisfy the statutory preference for treatment of the hazardous substances present at the site as a principal element because such treatment was not found to be practical or cost effective.

Five-year Review Requirements

The NCP, at 40 C.F.R. § 300.430(f)(4)(ii), requires a five-year review if the remedial action results in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure. Because this remedy will result in hazardous contaminants remaining on-site above levels that allow for unlimited exposure, a statutory review will be conducted within five years after initiation of the remedial action to ensure that the remedy is, or will be, protective of human health and the environment.

N. DOCUMENTATION OF SIGNIFICANT CHANGES FROM PREFERRED ALTERNATIVE OF PROPOSED PLAN

To fulfill CERCLA 117(b) and NCP [40 C.F.R. §§ 300.430(f)(5)(iii)(B) and 300.430(f)(3)(ii)(A)], the ROD must document and discuss the reasons for any significant changes made to the Selected Remedy.

The Proposed Plan was released for public comment in May 1999. It identified a PCB sediment clean up target of 1.0 ppm and Lower River and Inner Harbor Alternative 5, Inner Harbor Sediment Removal - Safe Navigational Depth as the Preferred Alternative for the sediment remediation in the Lower River and Inner Harbor.

The Proposed Plan recommendation of the 1.0 ppm target was selected based on use of the RME for human health risks and meeting the NOAEL to LOAEL range for ecological receptors evaluated. The selected soft sediment cleanup target of 0.5 ppm is based on the same overall human health and ecological risk exposure assumptions. However, two adjustments were made were made to the calculation for human health risk under the RME exposure scenario. The first adjustment was required as a result of a mistyped equation. The second adjustment was made as a result of an improved lipid figure in the derivation of the appropriate PCB concentration in small mouth bass. These adjustment require the selection of 0.5 ppm, as the soft sediment cleanup target, to meet a human health risk of 1.0×10^{-4}. The 0.5 ppm sediment target remains within the NOAEL to LOAEL range for fauna evaluated.

Under the recommended alternative for the Lower River and Inner Harbor, in the Proposed Plan, approximately 100,000 cubic yards of contaminated sediment between the Pennsylvania Avenue Bridge and the Inner Harbor mouth would be dredged. The removal of these sediment would create a 10 to 12 foot channel for recreational boats to travel in without disturbing contaminated sediments from prop wash or keel grounding. The estimated cost of this alternative was $26,900,000.

The remedy was preferred over the other possible Lower River and Inner Harbor alternatives because it provided the best overall balance of nine criteria based on the information available at the time. Removing contaminated sediments that were going to be disturbed by boat traffic would allow surficial sediments in the Inner Harbor to reach the PCB sediment goal.

This depth was determined based on information obtained from the City of Sheboygan and the U.S. Coast Guard through NOAA. According to the City of Sheboygan, the largest recreational vessels using the Inner Harbor required a water depth of 10 feet. In addition, the U.S. Coast Guard recommended a 2 foot buffer between the maximum depth necessary and harbor bottom for safe navigational purposes. Dredging to a depth of 12 feet exposes more highly contaminated sediments. Therefore, to allow for a 12 foot water depth and not expose highly contaminated sediments, the channel would be over-dredged an additional 2 feet and backfilled with 2 feet of clean sediment. This would create a 2 foot buffer between the contaminated sediment and the maximum water depth necessary. This 2 foot buffer would also allow for future maintenance dredging for safe navigation without disturbing PCB-contaminated sediments.

During the public comment period additional information obtained from the City of Sheboygan and comments submitted by the PRPs initiated a reevaluation of the depth and dredging boundaries of the proposed alternative. In addition, during the public comment period, the U.S. EPA National Remedy Review Board (NRRB) evaluated and submitted comments on the Inner Harbor preferred alternative.

<u>New Information obtained from the City of Sheboygan During the Public Comment Period</u>

Based on new and more detailed information nearly all of the motor and sailboats require only 7 feet of water depth. Only a small percentage of the largest sailboats need more than 7 feet of water. The frequency that these larger sail boats would significantly disturb contaminated sediments at depth is much less than previously anticipated.

<u>Information submitted from Tecumseh Products Company During the Public Comment Period</u>

According to a prop wash analysis submitted during the public comment period the top foot of sediment is potentially disturbed by motorboats. This analysis was reviewed by the USACE, which concurred with the general conclusions. One underlying assumption of the prop wash analysis was a minimum water depth of 5 feet. Areas of the Inner Harbor near the Pennsylvania Avenue Bridge routinely have less than 5 feet of water, which would mean that sediment in these areas may see prop wash effects beyond the top foot. The prop wash analysis also noted that the effects of high flow events are more likely to disturb surface sediment, than prop wash effects. The USACE concurred with this assessment.

Based on the concern that high flow events would disturb sediment at greater depths than recreational boats, a bathymetric analysis was performed. Bathymetrys dating back to 1979 were reviewed to determine if the Inner Harbor is primarily depositional in nature and to see what effects, if any, a number of high flow events within the last few years have had on the sediment surface of the Inner Harbor. As previously noted, the area of the Inner Harbor, between the 8th Street Bridge and Inner Harbor mouth is primarily depositional in nature. However, Areas B and C in Figures 16 and 17 have shown significant scour since 1991. Based on a review of harbor bathymetrys, very little additional sediment is expected to be deposited between the Pennsylvania and 8th Street Bridges.

The bathymetric analysis all of the Inner Harbor sediment data was “repositioned” to account for deposition and scour which occurred between the year the data was collected and 1999. An extrapolation of PCB concentrations using Earth Vision software, shows that high levels of PCB concentration are near the surface between the Pennsylvania Avenue and 8th Street Bridges. Water depths between the Pennsylvania Avenue and 8th Street Bridges range from 1 foot to 18 feet. However water depths greater than 8 feet occur just west of the 8th Street Bridge. Conversely, PCB concentrations near the surface between the 8th Street Bridge and harbor mouth are lower and water depths are generally deeper than 9 feet and go as deep at 17 feet. These factors have result in an Inner Harbor remedy that focuses on the removal of contaminated sediment from the Pennsylvania Avenue Bridge to just past the 8th Street Bridge. This is shown in Area A in Figure 15.

<u>Comments submitted by the NRRB</u>

On July 28, 1999, the National Remedy Review Board reviewed the U.S. EPA’s Proposed Plan preferred alternative for the Lower River and Inner Harbor. The NRRB comments focused on the following points.

- The board recommended that Region V conduct an analysis that shows how the sediment disturbances would result in unacceptable risks. In particular, the region should describe how the preferred alternative (dredging a deep channel from the harbor to the bridges in zones A, B, C, and D, but taking no action near shore) adequately reduces risk.

- Because the boat traffic in the Inner Harbor could redistribute contaminated sediment, the region proposes to dredge a narrow channel and use institutional controls to prevent boaters from disturbing sediment in other parts of the river.

> The board recommended that the region also consider alternatives that provide greater reliability over time and that require less care to maintain. For example, the region might consider shallower, but shore-to-shore dredging in all (or selected) areas to permit full use of the river by the vast majority of boaters. In addition, the region should consider an alternative that focuses on “hot spot” removal, which may also reduce overall contaminant remobilization predicted to occur from future navigational dredging actions.

The selected remedy for the Lower River and Inner Harbor recognizes the new information submitted during the public comment period and addresses the comments submitted by the NRRB. The Inner Harbor remedy has changed from a narrower and deeper dredging approach to a shallower shore-to-shore dredging approach. Because the Sheboygan River is a public waterway, institutional controls to limit boat traffic to the deeper channel or less contaminated areas will be ineffective. Even if possible, any limits placed on the use of the Inner Harbor would be contrary to reuse initiatives within the Superfund program. Therefore, the approach to dredging in the Inner Harbor of shore-to-shore of PCB contamination is not limited to any particular location. Based on the information obtained from the City of Sheboygan marina, over 95 percent of the recreational boats using the Inner Harbor require only 7 feet of water depth. Most of the Inner Harbor from the 8th Street Bridge to the harbor mouth has 7 feet of water or more. Therefore, recreational impacts are limited to within the top one foot of the sediment bed based on the prop wash analysis. However, most of the Inner Harbor between the Pennsylvania Avenue and 8th Street Bridges does not have very deep water. The U.S. EPA has selected shore-to-shore dredging of 2 feet, and backfilling to create a buffer between the prop wash disturbance “zone” and the more contaminated sediment below.

Areas B and C will be dredged an additional 2 feet and backfilled to remove PCB-contaminated sediments that are vulnerable to scour beyond the top 2 feet. These scour areas are based on a review of Inner Harbor bathymetry from 1979 to 1999. Consistent with the NRRB’s “hot spot” recommendation, any additional sediments just below the planned excavation depths equal to or greater than 26 ppm will be removed. The selected alternative calls for removal of approximately 53,000 cubic yards at a net present worth cost of approximately $10,000,000, including long-term monitoring, continued bathymetry analyses and maintenance of the breakwalls.

Lastly, the estimated remedy costs have come down since the Proposed Plan was issued. The cost reduction is due to less sediment being removed than called for in the Inner Harbor and because a different discount rate is being used for calculating the net present worth of all of the alternatives. The Feasibility Study assumed a discount factor of 5%. Now, consistent with Superfund guidance, a discount factor of 7% is used. This means that work that stretches over a number of years, like the Upper River dredging, or work that isn’t going to be initiated for a few years, like the Inner Harbor dredging, can have a total present net worth less than the calculated capital and annual O&M costs.

The estimated cost of the Upper River remedy has gone from $31.4 million to $23.8 million. The cost of the Lower River and Inner Harbor remedy has gone from $26.9 million to $10.0 million. Costs associated with the Floodplain Soil has only a slight reduction in cost. Costs associated with the Middle River and Groundwater are similar to the Proposed Plan costs.

Insert Exhibit 1

Exhibit 2 - Frequency of Soft Bottom Types Associated with State-wide Surveys of Fish Species Reported to Forage in the Sheboygan River [a]

Common Name	Scientific Name	Frequency of Bottom Type (%) [b]				
		Sand	Silt	Mud	Silt/Mud [c]	Total [d]
Smallmouth bass	*Micropterus dolomieu*	23	7	11	18	41
Rock bass	*Ambloplites rupestris*	26	9	13	22	48
Bluegill	*Lepomis macrochirus*	29	11	17	28	57
Pumpkinseed	*Lepomis gibbosus*	28	13	18	31	59
Black crappie	*Pomoxis nigromaculatus*	32	9	20	29	61
Common carp	*Cyprinus carpio*	29	9	19	28	57
White sucker	*Catostomus commersoni*	22	14	12	26	48
Redhorse species [e]	*Moxostoma* spp.	18-28	5-9	14-19	21-24	39-52
Common shiner	*Notropis cornutus* [f]	23	11	12	23	46
Sand shiner	*Notropis stramineus*	24	11	12	23	47
Horny head chub	*Nokomis biguttatus*	20	12	9	21	41
Longnose dace	*Rhinichthys cataractae*	20	10	7	17	37
Channel catfish [g]	*Ictaleurus punctatus*	2nd highest frequency	low frequency	highest frequency		
Stonecat	*Noturus flavus*	12	6	8	14	26
Walleye [g]	*Stizostedion vitreum*	highest frequency	low frequency	3rd highest frequency		
Blackside darter	*Percina maculata*	27	9	12	21	48
Log perch	*Percina caprodes*	34	7	10	17	51
Northern pike	*Esox lucius*	27	10	21	31	58

a) List of resident fish species that forage in the Sheboygan River is based on Table 2-1 of the AERA (1998).
b) Percentage frequency of bottom type "reported in the location of the collection" for fish surveys performed throughout Wisconsin over a 20-year period from the late 1950's to the late 1970's (Becker 1983). Other categories include gravel, rubble, boulders, bedrock, hardpan, detritus, clay, and marl.
c) Combined silt and mud frequencies.
d) Sum of sand, silt and mud frequencies.
e) Range of values for golden (*M. erythrurum*), silver (*M. anisurum*), and shorthead (*M. macrolepidotum*) redhorse.
f) Listed as *Luxilus cornutus* in Table 2-1 of the Sheboygan River and Harbor AERA (1998).
g) Bottom types qualitatively listed in descending order of frequency (Becker 1983).

Exhibits

Cost Tables

Appendix A - Responsiveness Summary

Appendix B - State Letter of Non-Concurrence

Appendix C - Administrative Record Index